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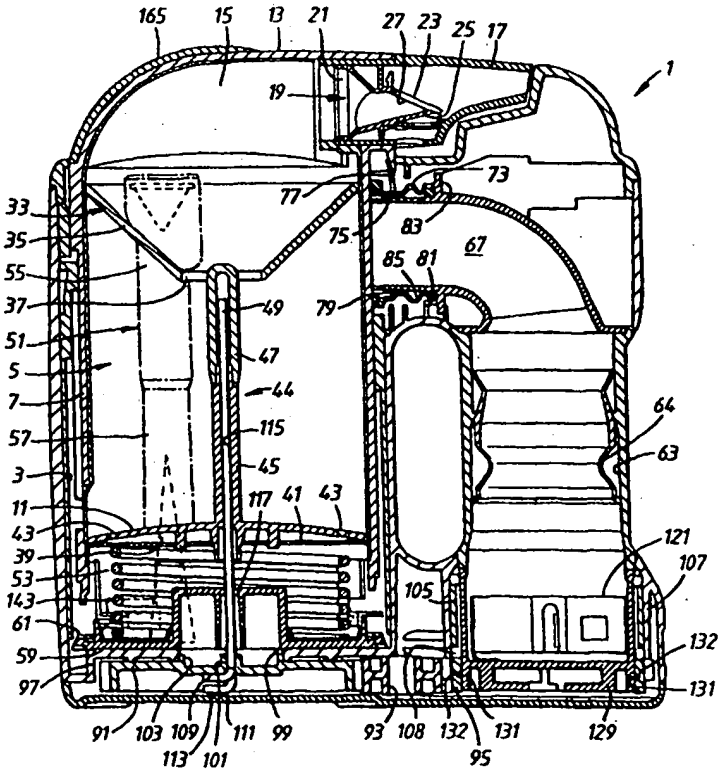
(57) Abstract

An inhalation device for providing a substance in a dispersion chamber for inhalation, the device including one or all of a slip clutch for driving an inhaler, apertures in the dispersion chamber to remove settled substance, a seal between a channel and the dispersion chamber, an enclosed passageway extending into the dispersion chamber from which rotational drive may be taken, a portion through which an indication on a housed inhaler may be viewed, a release mechanism for the piston of a suction chamber and a component for simultaneously operating the grip portion of a housed inhaler and opening an air path in the device.



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# INHALATION DEVICE

The present invention relates to an inhalation device for and a method of dispersing a particulate substance for inhalation.

Inhalers which dispense particulate substance, typically dry powder inhalers, are known. Such inhalers, as described for example in EP-A-0069715 and EP-A-0237507, typically include a storage chamber containing particulate substance, an inhalation channel through which air is in use inhaled and a dosing mechanism for metering a dose of particulate substance into the inhalation channel in readiness for inhalation.

For successful use, these inhalers do, however, require patients to be able to inhale at rates above certain minimum values. Some patients, such as paediatric and geriatric patients, are unable to generate the necessary flow rates and thus cannot use these inhalers as intended.

Inhalation devices have thus been developed which allow for the use of dry powder inhalers by patients who cannot generate the necessary inspiration flow rates. One such inhalation device is disclosed in EP-A-0548152 which includes a dispersion chamber into which a particulate substance to be inhaled by a patient is drawn using a negative pressure created by a spring-driven piston.

It is an aim of the present invention to provide an automatic and reliable way of operating a dosing mechanism of an inhaler.

According to the present invention there is provided an inhalation device for providing, in a dispersed state, a substance obtained from a dosing mechanism which is for providing a dose of said substance when moved from a first to a second position, the device comprising: a housing; a component movable relative to the housing between a storage position and an operative position; a drive mechanism for transferring movement of the component to the dosing mechanism; wherein the drive mechanism comprises a slip clutch

which allows relative movement between the component and the dosing mechanism when a resistance to movement of the dosing mechanism exceeds a threshold higher than the resistance to movement of the dosing mechanism from the first to the second position.

According to the present invention there is also provided a method of operating a dosing mechanism with a movable component of an inhalation device so as to provide a dose of substance in the inhalation device, the method comprising the steps of: providing a drive mechanism between the component and the dosing mechanism, the drive mechanism being arranged to move the dosing mechanism further than required to provide the dose when the component is moved from a storage position to an operative position; providing a slip clutch between the component and the dosing mechanism, the slip clutch allowing relative movement between the component and the dosing mechanism when a resistance to movement of the dosing mechanism exceeds a threshold higher than the force required to move the dosing mechanism to the position required to provide said dose such that the component may continue to move to the operative position.

In this way, a user may move an external component of the inhalation device to an operative position with no regard to internal operations of the inhalation device and yet the slip clutch ensures that the dosing mechanism is fully operated to release a dose of powder into the inhalation device. This enables a reliable automatic operation. Furthermore, it overcomes the problems of manufacturing direct drive mechanisms where tolerances must be arranged such that movement of the component to the operative position will result in the dosing mechanism being moved by precisely the right amount to release a dose of powder.

Preferably, the component comprises the mouthpiece and/or dispersion chamber of the inhalation device.

In this way, the user need only move the mouthpiece of the inhalation device out from its storage position to an operative position and yet be assured that the dosing mechanism has been reliably operated.

Preferably, the inhalation device is for use with a separate inhaler which itself houses the dosing mechanism. Where the inhaler has a rotatable manoeuvring portion with a substantially circular outer periphery for operating the dosing mechanism, the slip clutch may comprise an annular member for receiving and resiliently gripping the outer periphery of the manoeuvring portion. Where the manoeuvring portion has a ribbed outer periphery, the slip clutch may comprise at least one radially inwardly extending resilient portion for fitting between adjacent ribs of the manoeuvring portion.

In this way, no special slip clutch arrangement need be built into the inhalation device, since the required slip is arranged to occur directly between the annular member and/or the inwardly extending resilient portion and the manoeuvring portion of the inhaler. Furthermore, this arrangement does not hinder removal and replacement of an inhaler, but, with such a resilient annular member, makes insertion and removal more straightforward.

It is a further aim of the present invention to ensure that substance does not accumulate in the dispersion chamber of an inhalation device.

According to the present invention there is provided an inhalation device for containing a substance in a dispersed state, the device comprising: a dispersion chamber having walls for containing a substance in a dispersed state; wherein at least one of the walls includes edges defining a plurality of apertures through the at least one of the walls, each of the apertures allowing said substance to leave the dispersion chamber more easily than to enter the dispersion chamber.

According to the present invention there is also provided a method of preventing accumulation of substance in a dispersion chamber, the method comprising the steps of: providing one or more apertures through the thickness of at least one wall of the dispersion chamber; and shaping and sizing the apertures so as to allow more easily the substance to leave the dispersion chamber than to enter the dispersion chamber.

In this way, any substance which falls out of the dispersed state and settles on the wall of the dispersion chamber will tend to leave the dispersion chamber by way of one of the apertures. This is particularly effective when the wall is the bottom wall of the dispersion chamber where the powder will tend to settle.

Preferably, a secondary wall is provided outside the dispersion chamber such that the at least one of the walls and the secondary wall together define a collection chamber for collecting the substance which has left the dispersion chamber through the apertures.

This construction allows the inhalation device to retain its generally sealed form and, furthermore, prevents contamination of the outer surfaces of the inhalation device with the substance.

The apertures extend from an inner surface of the dispersion chamber to an outer surface of the dispersion chamber and are preferably shaped such that the apertures are smaller at the outer surface than at the inner surface.

In this way, the apertures tend to funnel substance out of the dispersion chamber, but provide a barrier to allowing substance back into the dispersion chamber.

As mentioned hereinabove, this arrangement is particularly advantageous when the apertures are located in the lower walls of the inhalation device with respect to its normal orientation during use and storage. This arrangement also provides the ability for self-cleaning without any action being required by the user.

In the case of dry powder inhalation devices at least, the substance to be contained by an inhalation device is hydroscopic. Indeed, it is desirable in any inhalation device to seal at least parts of the device from the external atmosphere when the device is not in use.

It is another aim of the present invention to provide an arrangement by which movement of a component seals or opens part of the inhalation device.

It is a yet further aim of the present invention to provide such an arrangement where the seal is reliable and can withstand regular movements between the storage and operative positions.

According to the present invention there is provided an inhalation device for providing a substance in a dispersed state, the device comprising: a housing; a component movable relative to the housing between a storage position and an operative position, the component having a peripheral surface defining an aperture and a closed surface adjoining the peripheral surface; a channel for ducting said substance, the channel defining an opening adjacent the component, the opening being aligned with the aperture when the component is in the operative position and opposite the closed surface when the component is in the storage position; and a sealing member having a sealing surface for providing a seal between the opening and both the closed surface and the peripheral surface; wherein the sealing member is provided with at least one protrusion extending beyond the sealing surface and, at both the storage and operative positions, the closed surface and the peripheral surface is provided with at least one recess corresponding to the at least one protrusion such that the sealing surface seals with the closed surface when the component is in the storage position and seals with the peripheral surface when the component is in the operative position, but is held away from the closed surface and the peripheral surface by the at least one protrusion for any position intermediate the operative position and the storage position.

According to the present invention there is also provided a method of sealing an opening of a feed channel to a moveable component, the moveable component having a peripheral surface defining an aperture and a closed surface adjoining the peripheral surface, the method comprising the steps of: providing a sealing member with a sealing surface for sealing between the opening and both the closed surface and the peripheral surface; providing on the sealing member at least one protrusion extending beyond the sealing surface; providing in both a predetermined position of the closed surface and the peripheral surface at least one recess corresponding to the at least one protrusion such that the sealing

surface seals with the closed surface at the predetermined position and with the peripheral surface when the opening is aligned with said aperture. but is held away from the closed surface and the peripheral surface by the at least one protrusion for any intermediate position.

In this way, by merely moving the component relative to the opening of the channel, the opening may be selectively sealed against a closed surface or around an aperture into another part of the inhalation device. Furthermore, by providing the protrusion, relative movement between the opening and the component does not wear the sealing surfaces around the opening. This is particularly advantageous where the sealing surfaces are made of a relatively delicate substance suitable for good sealing. In this case, the protrusion can be made of a more hard wearing material.

The component may comprise any appropriate part of the inhalation device and may be of a planar form. However, in a preferred embodiment, the component comprises a dispersion chamber for containing the substance in a dispersed state and which moves axially and rotationally relative to the housing between the operative and storage positions, the dispersion chamber having an outer cylindrical surface comprising the closed and peripheral surfaces.

In this way, when the user moves the dispersion chamber from its storage position to its operative position, the channel is automatically moved from a sealed position to a position in which it is aligned with and sealed to an aperture in the wall of the dispersion chamber.

Preferably, the channel is in fluid connection with a chamber from which a dose of the substance may be provided and is for ducting the dose to the dispersion chamber.

It is a still further aim of the present invention to provide automatic operation of a mechanism which provides a substance for dispersion by rotating the dispersion chamber of an inhalation device about its axis.

According to the present invention there is provided an inhalation device for providing a substance in a dispersed state, the device comprising: a housing; a dispersion chamber having walls for containing a substance in a dispersed state, the dispersion chamber being mounted in the housing so as to be axially and rotatably movable; a mechanism for providing said substance for dispersion; and an elongate member for transferring rotational movement of the dispersion chamber to the mechanism; wherein the dispersion chamber includes an enclosed passageway extending axially inwardly of the dispersion chamber from one of the walls, the elongate member being axially movable into and out of the passageway through the one of the walls.

According to the present invention there is also provided a method of transferring rotational movement of an inhalation device dispersion chamber to a mechanism for providing a substance for dispersion in the dispersion chamber, the method comprising the steps of: providing an elongate member axially of the dispersion chamber for transferring rotation of the dispersion chamber to the mechanism; and providing an enclosed passageway extending axially inwardly of the dispersion chamber from one of the walls defining the dispersion chamber, the elongate member being axially movable into and out of the passageway through the one of the walls.

In this way, rotation of the dispersion chamber may rotate the elongate member so as to provide a drive for the inhalation device mechanism. The use of an elongate member is advantageous, since it allows continuous drive from the dispersion chamber irrespective of the axial relative position between the elongate member and the dispersion chamber. In this way, when the inhalation device is not in use, the dispersion chamber may be collapsed inwardly of the inhalation device in a telescopic manner with the elongate member merely moving into a position in which it extends inside the dispersion chamber.

The inhalation device of the present invention is particularly advantageous in the provision of the enclosed passageway extending axially inwardly of the dispersion chamber. Normal design considerations would lead one to provide merely a suitably shaped aperture in the dispersion chamber, the aperture allowing drive to the elongate member whilst also

allowing axial movement between the elongate member and the dispersion chamber. However, in this way, the elongate member and any seals in the aperture of the dispersion chamber through which the elongate member passes may become contaminated with the dispersed substance, thereby causing undue wear and resistance to movement. By providing an enclosed passageway, the present invention provides a more simple structure with no need for seals and yet provides a structure in which there is no possible contact between the dispersed substance and the elongate member.

Preferably, the elongate member has a generally flat cross-section.

In this way, the torque transmitted from the dispersion chamber to the elongate member may be maximized whilst, by orientating the elongate member appropriately relative to the dispersion chamber, the effects of the passageway extending into the dispersion chamber to fluid flow in the dispersion chamber may be minimized.

When providing an inhaler in an inhalation device for containing substance in a dispersed state, it is desirable to contain the inhaler in the inhalation device such that, during storage, the inhalation device is sealed from the atmosphere and, during operation, is sealed such that air may only be drawn through its inhalation channel. There may be a problem, therefore, that the user cannot tell any number of varying states of the inhaler whilst it is contained in the inhalation device. In particular, the user cannot be confident of the type of substance being dispersed in the inhalation device. Furthermore, the user is not provided with any indication of when the reservoir of substance may run out, unless the inhalation device is itself provided with some counting mechanism.

According to the present invention there is provided an inhalation device for containing in a dispersed state a substance provided from an inhaler having an outer surface with an indication of a state of the inhaler, the device comprising: a housing having a chamber for receiving the inhaler, wherein the housing comprises a portion through which the indication on the inhaler may be viewed by the user.

According to the present invention there is also provided a method of indicating to a user a state of an inhaler housed in an inhalation device which is for containing in a dispersed state a substance provided from the inhaler, the method comprising the step of: providing a portion in the inhalation device through which an indication of the state of the inhaler provided on the inhaler may be viewed by the user.

In this way, even with the inhaler contained in the inhalation device, a user may make use of any indication provided on the inhaler itself.

The entire housing chamber may be transparent or open such that any printed information on the inhaler may be read by the user. Alternatively, where a portion of the inhaler, for instance the manoeuvring portion which is rotated to operate the inhaler, is colour coded according to the contained medicament, it may be sufficient for an appropriate portion of the inhalation device to be translucent. Similarly, where an inhaler provides an indication of the number of doses dispensed or remaining, the user may make use of this information and it is unnecessary for the inhalation device itself to have a counting mechanism.

In a preferred embodiment the inhaler is housed wholly within the inhalation device and transparent/translucent materials are located accordingly. However, by providing an appropriate seal around the mouthpiece of the inhaler at least, it would be possible to provide an inhalation device where the portion through which the indication on the inhaler may be viewed is merely an open portion.

It is undesirable for an inhalation device containing a substance in a dispersed state to be used with different substances.

According to the present invention there is provided a method of ensuring that an inhalation device for containing in a dispersed state a substance provided from an inhaler is always used with the same type of substance, the method comprising the steps of: providing on an outer surface of an inhaler an indication of the type of substance to be dispensed by the inhaler; providing a portion on the inhalation device through which the

indication on the inhaler may be viewed by the operator; and providing on the inhalation device an indication of the type of substance to be contained by the inhalation device.

In this way, a user may easily ensure that the inhalation device is always used with the same and appropriate type of substance.

Preferably, the indication on the inhalation device is provided in such a way that its removal will permanently damage the inhalation device. In this way, it will be immediately apparent to the user that the inhalation device has been tampered with.

It is another aim of the present invention to provide an arrangement whereby a suction chamber is automatically operated.

According to the present invention there is provided an inhalation device for containing a substance in a dispersed state, the inhalation device comprising: a suction chamber defined by a cylindrical wall and two end faces movable together rotationally relative to the cylindrical wall and movable axially relative to one another along the cylindrical wall; and an intermediate component mounted on one of the two end faces and facing the other of the two end faces, the intermediate component being movable relative to the two end faces so as to engage and disengage with the other of the two end faces; wherein the cylindrical wall is provided with release means for engaging the intermediate component such that, with the intermediate component engaging the other of the two end faces, at a predetermined position in the rotation of the two end faces relative to the cylindrical wall, the release means causes the intermediate component to disengage the other of the two end faces.

According to the present invention there is also provided a method of engaging and releasing from one another two end faces which, together with a cylindrical wall, define a suction chamber, the two end faces being movable together rotationally relative to the cylindrical wall and movable axially relative to one another along the cylindrical wall, the method comprising the steps of: mounting an intermediate component on one of the two end faces so as to face the other of the two end faces and mounting the intermediate

component so as to be movable relative to the two end faces so as to engage and disengage with the other of the two end faces: and providing the cylindrical wall with release means for engaging the intermediate component such that, with the intermediate component engaging the other of the two end faces, at a predetermined position in the rotation of the two end faces relative to the cylindrical wall, the release means causes the intermediate component to disengage the other of the two end faces.

In this way, the piston of a suction chamber may be automatically released when it reaches a predetermined rotational position relative to the cylindrical wall. This arrangement is particularly useful, since it allows both end faces of the walls defining the suction chamber to be movable both axially and rotationally and yet be released from one another at a well defined predetermined position.

In a preferred embodiment one end face is a piston and the other end face is the bottom wall of a dispersion chamber which is telescopically housed in the cylindrical wall. When the dispersion chamber is extended from the cylindrical wall, the piston is drawn with it by means of the intermediate component. When the dispersion chamber is then rotated to its operative position, the piston is rotated with it, but, immediately prior to reaching the operative position, the intermediate component engages with the release means on the inner surface of the cylindrical wall so as to release the piston. Preferably, a spring is provided between the piston and the lower wall of the dispersion chamber such that the piston is forced away from the dispersion chamber, thereby forming a reduced pressure in the suction chamber defined between the piston and the dispersion chamber.

In another preferred embodiment the intermediate component is mounted so as to be rotationally movable relative to the piston. However, it is sufficient for the intermediate component to be movable by means on the cylindrical wall so as to disengage the opposite end face of the suction chamber. For instance, the intermediate component could be biased radially outwardly towards the cylindrical wall and a cam surface could be provided on the cylindrical wall so as to move the intermediate component radially inwardly and thereby release engagement with the opposite end face.

Since many substances, particularly dry powders, are hydroscopic, it is desirable to seal them from the atmosphere when the device is not in use.

It is a yet further aim of the present invention to at least partially seal an inhaler in an inhalation device when the inhalation device is not in use.

According to the present invention there is provided an inhalation device for containing a substance in a dispersed state, the inhalation device comprising: a portion for receiving an inhaler having a manoeuvring means for operating a dosing mechanism to release a dose of said substance; and a component adjacent the portion for moving the manoeuvring means; wherein movement of the component to move the manoeuvring means also selectively opens and closes an air path of the inhalation device.

According to the present invention there is also provided a method of selectively opening an air path of an inhalation device, the air path being for allowing air through an inhaler housed in the inhalation device, the method comprising the steps of: providing a component for moving the manoeuvring means of an inhaler held in the inhalation device for releasing a dose of substance; and mounting the component in the inhalation device such that as the component moves the manoeuvring means of the inhaler, the component additionally opens the air path of the inhalation device.

In this way, with operation of the inhaler to release a dose of substance, the device automatically opens a path for air flow through the inhaler. The user is not required to perform any additional operations and sealing and opening of the connection to the inhaler occurs automatically.

Movement of the component can be used to open and close any portion of the flow path through the inhaler, but it is preferably provided to open and close an air inlet.

Similarly, the inhaler may be sealed to the inhalation device around only the inlet and outlet thereof, but is preferably housed in a chamber with the component selectively opening and closing an opening to the chamber.

Preferably, the manoeuvring means is rotatable to release a dose of the substance and the component is a rotatable component provided at one end of the chamber for rotating the manoeuvring means, the rotatable component moving axially of the chamber with relative rotation and the axial movement selectively opening and closing the opening to the chamber.

This arrangement provides a structure which is simple to construct and reliable in operation. In order to release a dose of powder into the inhalation device, it is always necessary to operate the manoeuvring means and, by virtue of the present invention, the inhaler is automatically sealed or opened.

A preferred embodiment of the present invention will now be described hereinbelow, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a vertical sectional view of an inhalation device in accordance with a preferred embodiment of the present invention, with the dispersion chamber in the closed or storage position;

Figure 2 illustrates a vertical sectional view of the inhalation device of Figure 1, with the dispersion chamber in the retracted or extended, but non-operated, position;

Figure 3 illustrates a vertical sectional view of the inhalation device of Figure 1, with the dispersion chamber in the operative position;

Figure 4 illustrates a vertical sectional view of the inhalation device of Figure 1, with the dispersion chamber in the extended, but non-rotated, position after operation;

Figures 5(a) to (c) illustrate parts of a valve suitable for use in the inhalation device of Figure 1;

Figure 6(a) illustrates a bottom view of the separating member of the inhalation device of Figure 1;

Figure 6(b) illustrates a vertical sectional view along section A-A of the separating member of Figure 6(a);

Figures 7(a) and (b) illustrate orthogonal side views of the lower wall section of the dispersion chamber of the inhalation device of Figure 1;

Figure 7(c) illustrates a plan view of the lower wall section of Figures 7(a) and (b);

Figure 7(d) illustrates a part-sectional view of the lower wall section of Figures 7(a) and (b);

Figure 8 illustrates in enlarged scale a horizontal sectional view through a lower part of the passageway of the dispersion chamber of the inhalation device of Figure 1;

Figure 9(a) illustrates an exploded perspective view of the dispersion chamber and the sealing unit of the inhalation device of Figure 1;

Figure 9(b) illustrates a perspective view of the seal of the sealing unit of the inhalation device of Figure 1;

Figure 10 illustrates a bottom view (with base removed) of the gear assembly of the drive mechanism of the inhalation device of Figure 1;

Figures 11(a) and (b) illustrate bottom and side views of the mounting gear of the drive mechanism of the inhalation device of Figure 1;

Figures 12(a) to (c) illustrate a horizontal sectional, plan and perspective views of the resilient ring of the slip clutch of the drive mechanism of the inhalation device of Figure 1;

Figures 13(a) and (b) illustrate side and bottom views of the sealing cap of the mounting gear of the drive mechanism of the inhalation device of Figure 1;

Figure 14 illustrates a side view of the bottom wall member of the accumulation prevention means of the inhalation device of Figure 1;

Figure 15 illustrates a perspective view of the piston base of the piston assembly of the inhalation device of Figure 1;

Figures 16(a) and (b) illustrate side and plan views of the catch plate of the piston assembly of the inhalation device of Figure 1;

Figure 17 illustrates a plan view of the piston assembly of the inhalation device of Figure 1;

Figure 18 illustrates an exploded perspective view of the piston base, the catch plate and the bottom wall member of the accumulation prevention means of the inhalation device of Figure 1; and

Figure 19 illustrates a perspective view of a powder inhaler suitable for use in the inhalation device of Figure 1.

The inhalation device comprises a housing 1 which defines a cavity 3 in which a dispersion chamber 5 is telescopically mounted. The dispersion chamber 5 comprises a generally cylindrical main body 7 which includes an opening 9 that allows for fluid communication with an inhaler 10 when the dispersion chamber 5 is in the operative position as will be described in detail hereinbelow, a first wall section 11 located at the lower end of the main

body 7 and a second wall section 13 which acts to enclose the upper end of the main body 7.

The upper wall section 13 of the dispersion chamber 5 defines an outlet channel 15 to which a mouthpiece 17 is connected. The upper wall section 13 may be formed as a separate component to the remainder of the dispersion chamber 5, or, as in this embodiment, as an integral component of the dispersion chamber 5. In use, the mouthpiece 17 will be taken in the lips of a user. The mouthpiece 17 is preferably detachable from the outlet channel 15, for instance by means of a bayonet fitting. In this way, the mouthpiece 17 may be removed for cleaning or replacement. Where the inhalation device is to be used by a paediatric patient, a face mask is required. The face mask can either be fitted to the mouthpiece 17 or directly to the outlet channel 15 with the mouthpiece 17 removed. The outlet channel 15 is provided with a one-way valve 19. The one-way valve 19 is preferably located in the mouthpiece 17 so as to allow for cleaning or removal at the same time as the mouthpiece 17. When the inhalation device is used and the user inhales through the mouthpiece 17, the one-way valve 19 opens to let inhaled air pass through the mouthpiece 17. On the other hand, when the user exhales, the one-way valve 19 closes to prevent exhaled air entering the outlet channel 15 and hence the dispersion chamber 5. In this embodiment, the one-way valve 19 is a flap valve. However, it will be appreciated that other kinds of valve could be used. The one-way valve 19 comprises an insert 21, which is an interference fit within the mouthpiece 17, and a valve flap 23. The insert 21 comprises a valve seat 25, an aperture 27 and a bearing 29. The valve flap 23 comprises a shaft 31 which is located in the bearing 29 to allow free rotation of the valve flap 23. In this embodiment the shaft 31 is retained in the bearing 29 by a part of the bearing 29 which has to be displaced to allow the shaft 31 to be located in and removed from the bearing 29. In an alternative embodiment, as illustrated in Figures 5(a) to (c), the bearing 29 could be arranged such that when the insert 21 is located in the mouthpiece 17 the inner wall of the mouthpiece 17 closes the bearing 29 and prevents escape of the shaft 31.

The dispersion chamber 5 further comprises a separating member 33 which separates the main body 7 from the outlet channel 15. In this embodiment the separating member 33 comprises a hollow downwardly-directed frusto-conical section 35 which has a lower central opening 37. The purpose of the conical section 35 is to prevent substance which has come out of the dispersed state in the dispersion chamber 5 from escaping from the dispersion chamber 5, particularly when the inhalation device is turned upside down. When the inhalation device is turned upside down the conical section 35 provides a peripheral channel in which substance is trapped and cannot pass back through the opening 37. It will be appreciated that the separating member 33 can be other than a conical section. For example, the separating member 33 could be a polygonal section.

The dispersion chamber 5 further comprises means for preventing substance accumulating within the main body 7 of the dispersion chamber 5 during use. The accumulation prevention means comprises a space 39 defined by the lower wall section 11 of the dispersion chamber 5 and a further wall section 41, which is a substantially flat member, located below the lower wall section 11 of the dispersion chamber 5. The lower wall section 11 of the dispersion chamber 5 includes a plurality of elongate through-holes 43. The through-holes 43 are tapered and the opening thereof facing into the main body 7 of the dispersion chamber 5 is of greater area than the opening thereof facing into the space 39. With this construction, substance which settles on the lower wall section 11 of the dispersion chamber 5 tends to flow down easily through the through-holes 43 into the space 39. In contrast, if the inhalation device is turned upside down, substance will flow back much less readily into the main body 7 of the dispersion chamber 5 from the space 39 as the smaller openings of the through-holes 43 presented to the space 39 hinder the flow of substance back into the main body 7 of the dispersion chamber 5. In practice, substance which would otherwise accumulate within the main body 7 of the dispersion chamber 5 tends to flow through the through-holes 43 and be retained in the space 39. In order to achieve good retention of substance in the space 39, the shortest distance, that is the width, of the openings of the through-holes 43 facing into the space 39 is preferably about 0.5mm. The provision of through-holes 43 in the form of elongate slots is particularly preferred, since such slots allow for the secure support of a passageway 44 which extends upwards

from the lower wall section 11 of the dispersion chamber 5 as will be described hereinbelow, and allows for an effective flow of gas over the surface of the lower wall section 11 of the dispersion chamber 5 from within the main body 7 of the dispersion chamber 5. It will nevertheless be appreciated that the through-holes 43 may be formed other than as elongate slots. Examples are arcuate slots and circular holes.

The dispersion chamber 5, as mentioned hereinabove, further comprises a fully enclosed passageway 44 whose major part extends upwards from the lower wall section 11 of the dispersion chamber 5 into the opening 37 in the conical section 35 of the dispersion chamber 5. In this embodiment the passageway 44 is constructed from two parts, a first part 45 having a major portion which extends upwards from the lower wall section 11 of the dispersion chamber 5 and a minor portion which extends downwards from the lower wall section 11 of the dispersion chamber 5 so as to sealingly engage a central slot 48 in the lower wall section 41 of the accumulation prevention means, and a second part 47 which is a downward extension of the conical section 35 of the dispersion chamber 5 and extends across the opening 37 in the conical section 35. Preferably, the first part 45 is formed as an integral moulded part of the lower wall section 11, and the second part 47 is formed as an integral moulded part of the conical section 35. Although the entire passageway 44 can be formed in many other ways, for instance as a single integral moulding with the lower wall section 11 of the dispersion chamber 5, the construction of the passageway 44 of this embodiment in two parts is particularly advantageous. The passageway 44 is located in the dispersion chamber 5 at a position opposite the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5. The passageway 44 thus lies in the path of the air/substance dispersion which enters the dispersion chamber 5. By incorporating a generally flat passageway 44 and by arranging for the long dimension of the passageway 44 to extend normally to the plane of the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5, that is, in the principal direction of flow, disruption to the flow of the air/substance dispersion is minimised. The edge of the passageway 44 adjacent the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5 is also preferably tapered, as illustrated in Figure 8, so as further to minimise flow disruption. The passageway 44 receives an elongate member 49 as will be described hereinbelow, such

that, when the dispersion chamber 5 is moved telescopically into and out of the cavity 3 in the housing 1, the elongate member 49 moves into and out of the dispersion chamber 5 without the need for any seals between any part of the dispersion chamber 5 and the elongate member 49.

The dispersion chamber 5 further comprises a further passageway 51 whose major part extends upwards from the lower wall section 11 of the dispersion chamber 5 and provides communication between a region at the top of the dispersion chamber 5 and a suction chamber 53 which will be described in detail hereinbelow. The passageway 51 is formed of two parts, an upper tubular section 55 which is a downward extension of the conical section 35 of the dispersion chamber 5 and a lower tubular section 57 whose major portion is an upward extension of the lower wall section 11 of the dispersion chamber 5 and whose minor portion is a downward extension of the lower wall section 11 of the dispersion chamber 5 which sealingly engages an opening 58 in the wall section 41 of the accumulation prevention means. Preferably, the lower tubular section 57 is formed as an integral moulded part of the lower wall section 11, and the upper tubular section 55 is formed as integral moulded part of the conical section 35.

By virtue of the configuration of the separating member 33 and the lower wall section 11 of the dispersion chamber 5, it will be appreciated that the separating member 33 and the lower wall section 11 of the dispersion chamber 5 may be simply fitted together.

The housing 1 further comprises a suction chamber 53 of variable volume located in the cavity 3 below the dispersion chamber 5. The suction chamber 53 is defined by the wall section 41 of the accumulation prevention means located at the bottom of the dispersion chamber 5, the peripheral wall of the cavity 3 and a piston assembly 59 mounted axially below the wall section 41. The piston assembly 59 includes a peripheral ring seal 61 which acts to ensure that the piston assembly 59 is in sealing engagement with the inner surface of the wall of the cavity 3.

The housing 1 further comprises a cavity 63 for removably receiving an inhaler 10. The cavity 63 includes a pair of inwardly biased resilient catches 64, in this embodiment diametrically opposed, which are adapted to grip the body portion 71 of the inhaler 10 so as to fix that part rotationally with respect to the housing 1. The cavity 63 is connected to the dispersion chamber 5 by an L-shaped channel 67 which acts to provide fluid communication between the cavity 63 and the dispersion chamber 5 when the dispersion chamber 5 is in the operative position. In this embodiment, the inhaler 10 is a TURBUHALER dry powder inhaler. TURBUHALER is a registered trademark of Astra AB, Sweden. The inhaler 10 comprises a mouthpiece 69, a body portion 70 which includes an inhalation channel leading to the mouthpiece 69, a reservoir containing particulate substance to be inhaled and a dosing mechanism for providing a metered dose of the substance in the inhalation channel, and a grip portion 71 for operating the dosing mechanism to ready the inhaler for use. It will, of course, be understood that the inhalation device of the present invention is not restricted to the use of a TURBUHALER dry powder inhaler, but that the inhalation device can be adapted to incorporate other similar kinds of inhaler.

The inhalation device further comprises a sealing unit 73 at the end of the channel 67 adjacent the dispersion chamber 5. The sealing unit 73 is provided to prevent moisture from entering the cavity 63, and hence into the inhaler 10, via the channel 67. It will be understood that it is important to ensure that the inhaler 10 is exposed as little as possible to atmosphere as many pharmaceutically active substances are hydroscopic. The sealing unit 73 comprises a shaped seal 75 and a biasing means 77, in this embodiment a spring plate. As can be seen from Figure 9(a), the channel 67 is only in fluid communication with the dispersion chamber 5 when the dispersion chamber 5 is in the operative position and the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5 is adjacent the sealing unit 73.

The seal 75 is generally tubular and is disposed around the end of the channel 67 adjacent the outer wall of the main body 7 of the dispersion chamber 5. The seal 75 includes first and second sealing surfaces 79, 81, in this embodiment ring seals, at each end thereof,

which respectively engage the outer wall of the main body 7 of the dispersion chamber 5 and a flange 83 extending around the channel 67. The seal 75 further includes a corrugated or bellows like portion 85 which provides for axial extendibility of the seal 75. In using an axially-extendible seal 75, the material of the seal 75 need not be of such resilience as to provide axial extendibility, but rather can be selected from the standpoint of achieving optimal sealing with the outer wall of the main body 7 of the dispersion chamber 5. The biasing means 77 acts to bias the first sealing surface 79 of the seal 75 against the outer wall of the main body 7 of the dispersion chamber 5. Thus, the seal 75 seals the channel 67 to the outer wall of the main body 7 of the dispersion chamber 5 when the dispersion chamber 5 is in the closed position and seals the channel 67 to the outer periphery of the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5 when the dispersion chamber 5 is in the operative position. The seal 75 is preferably formed from two materials as a single moulding. The sealing surfaces 79, 81, which respectively seal with the outer wall of the main body 7 of the dispersion chamber 5 and the flange 83 on the channel 67 are made from a softer material than the remainder of the seal 75. The seal 75 further includes two projections 87 on a part which opposes the outer wall of the main body 7 of the dispersion chamber 5. In this embodiment the projections 87 are elongate elements which extend in the circumferential direction. When the dispersion chamber 5 is axially displaced and rotated between the closed position and the operative position, the projections 87 slide against the outer wall of the main body 7 of the dispersion chamber 5 and space the first sealing surface 79 of the seal 75 away from the outer wall of the main body 7 of the dispersion chamber 5, thereby preventing the first sealing surface 79 of the seal 75 from being unnecessarily damaged during use. The outer wall of the main body 7 of the dispersion chamber 5 is provided with recesses 89a, 89b which are arranged to receive the projections 87 of the seal 75 when the dispersion chamber 5 is in the closed position and the operative position respectively. In the closed position, the projections 87 of the seal 75 locate in the recesses 89a, such that the first sealing surface 79 of the seal 75 contacts the outer wall of the main body 7 of the dispersion chamber 5. In the operative position, the projections 87 of the seal 75 locate in the recesses 89b, such that the first sealing surface 79 of the seal 75 seals against the outer periphery of the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5. It will be appreciated that the

projections 87 of the seal 75 and the corresponding recesses 89a, 89b in the outer wall of the main body 7 of the dispersion chamber 5 may be other than elongate and that any number of projections may be employed. For example, it is envisaged that the seal 75 could be provided with a single circular projection and that the outer wall of the main body 7 of the dispersion chamber 5 could be provided with a corresponding recess arranged around the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5. The arrangement employed in the present invention is, however, preferred, since the projections 87 never traverse the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5. It will be appreciated that if the projections 87 were to traverse the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5 then the projections 87 could be damaged by the exposed edge of the opening 9 in the outer wall of the main body 7 of the dispersion chamber 5.

In this embodiment the sealing unit 73 further comprises a cam mechanism which operates on the biasing means 77 so as to bias the first sealing surface 79 of the seal 75 towards the outer wall of the main body 7 of the dispersion chamber 5 when the dispersion chamber 5 is in the closed position. In an alternative embodiment the cam mechanism can be arranged also to bias the first sealing surface 79 of the seal 75 towards the outer wall of the main body 7 of the dispersion chamber 5 when the inhalation device is in the operative position. At any other position, the resilience of the seal 75 will be sufficient to retain the seal 75 in position, but insufficient to cause unnecessary wear of the first sealing surface 79 of the seal 75 on the outer wall of the main body 7 of the dispersion chamber 5 as the dispersion chamber 5 is moved during use between the closed position and the operative position.

The inhalation device further comprises a mechanism for automatically rotating the grip portion 71 of the inhaler 10 as the dispersion chamber 5 is rotated to the operative position, thereby providing a metered dose of particulate substance in the inhalation channel of the inhaler 10 in readiness for use. The mechanism includes an elongate member 49, in this embodiment a flat member, which extends axially through the suction chamber 53 and the

dispersion chamber 5, and first, second and third gears 91, 93, 95 disposed in the base of the housing 1.

The first gear 91 is the drive gear and is located in a space defined between the base of the housing 1 and a base member 97 spaced upwardly therefrom. The base member 97 includes a central, preferably circular, opening 99. The drive gear 91 includes a centrally located slot 101 and an axial upwardly-directed extension 103 which is located about the slot 101. The upwardly-directed extension 103 is located in the opening 99 in the base member 97, thereby positionally securing the drive gear 91. The second gear 93 is an intermediate gear which is provided to rotate the third gear 95 on rotation of the drive gear 91, and hence the grip portion 71 of the inhaler 10 through the angle necessary to meter a dose of particulate substance into the inhalation channel of the inhaler 10. The third gear 95 is a mounting gear in which the grip portion 71 of the inhaler 10 is mounted. The mounting gear 95 has an axial upwardly directed and generally cylindrical wall 105 on the outer surface of which is formed a male thread 106. The male thread 106 is configured to engage a corresponding female thread 107 formed in an inner surface of the inhalation device and causes the mounting gear 95 to be moved axially downwards with rotation. That is, when the dispersion chamber 5 is moved between the closed position and the operative position, the mounting gear 95 is both rotated and moved axially downwards. This axial movement causes openings 108 in the wall 105 of the mounting gear 95 to be exposed through which air may be drawn into the device and through the inhaler 10.

The elongate member 49 extends through a slot 115 in the lower wall member 11 of the dispersion chamber 5 and is fixed in the slot 101 in the drive gear 91. It will be appreciated that the elongate member 49 could take any form suitable to act as a shaft, but the use of a flat plate is particularly advantageous. The elongate member 49 is secured in the slot 101 in the drive gear 91 by two flanges 109. The elongate member 49 also includes a further central flange 111 which contacts, preferably with a generally part-spherical projection 113, the inner surface of the base of the housing 1 and forms a bearing surface. The elongate member 49 is preferably made from a metal or a deformable material, such that the flanges 109, 111 may be formed by bending a part of the elongate member 49. In

passing through the suction chamber 53 and the dispersion chamber 5, the elongate member 49 extends through the opening 99 in the base member 97 and through a centrally located slot 117 in a piston base 118 of the piston assembly 59. In this embodiment the slot 117 in the piston base 118 through which the elongate member 49 extends is configured so as to sealingly engage with the elongate member 49. Alternatively, one or more seals could be provided in the slot 117 to ensure a sealing fit between the elongate member 49 and the slot 117. However, the use of seals is not preferred as the presence of particulate substance is prone to restrict movement and cause wear of the moving parts. Therefore, it is desired to prevent any previously dispersed substance contacting the various operating parts of the inhalation device.

With this arrangement, when the dispersion chamber 5 is rotated, the elongate member 49 rotates concomitantly with the dispersion chamber 5, thereby rotating the gears 91, 93, 95 of the drive mechanism and hence the grip portion 71 of the inhaler 10.

The slot 115, which extends through the passageway 44 in which the elongate member 49 is guided, has a major part which is wider than the thickness of the elongate member 49, and includes ribs 119 which extend along the axial length of the passageway 44. The distance between opposing ribs 119 corresponds substantially to the thickness of the elongate member 49. With this construction, not only is the elongate member 49 held securely in the passageway 44 and rotation of the dispersion chamber 5 transferred effectively to the elongate member 49, but the resistance to axial movement of the elongate member 49 in the passageway 44 is much reduced than if the slot 115 in the passageway 44 were to have a similar cross-section to that of the elongate member 49. This is because there is less surface contact and therefore less friction and also because the spaces around the elongate member 49 allow movement of air into and out of the passageway 44. In addition, the passageway 44 may be more easily moulded than one which has the same cross-section of the elongate member 49 since the design tolerances need not be so precise.

The drive mechanism further comprises a slip clutch in order to ensure that rotation of the dispersion chamber 5 from the closed position to the operative position rotates the grip

portion 71 of the inhaler 10 by the angle required to meter a dose of particulate substance into the inhalation channel of the inhaler 10. In practice, variations in tolerances can result in the grip portion 71 of the inhaler 10 being turned insufficiently or the grip portion 71 of the inhaler 10 being rotated fully before the dispersion chamber 5 has reached the operative position, such that the inhalation device cannot be operated. The slip clutch is provided between the grip portion 71 of the inhaler 10 and the mounting gear 95. The gears 91, 93, 95 of the drive mechanism are arranged such that, when the dispersion chamber 5 is rotated between the closed position and the operative position, the mounting gear 95 is turned further than is required to operate the grip portion 71 of the inhaler 10. Once the mounting gear 95 has been rotated sufficiently so as fully to rotate the grip portion 71 of the inhaler 10 and the grip portion 71 of the inhaler 10 reaches the limit of travel, the slip clutch then allows the mounting gear 95 to continue to rotate, thereby ensuring the dispersion chamber 5 is rotated to the operative position.

In this embodiment the slip clutch comprises a ring 121 of resilient material, such as spring steel. The ring 121 includes an inwardly-directed projection 123 which is adapted to engage in grooves 125 or against the flanks 127 of the grooves 125 on the grip portion 71 of the inhaler 10. Thus, when the inhaler 10 is fitted into the inhalation device, the grip portion 71 of the inhaler 10 is located within the ring 121. The ring 121 is operably connected to the mounting gear 95 such that drive from the mounting gear 95 to the grip portion 71 of the inhaler 10 is transmitted via the projection 123. When the grip portion 71 of the inhaler 10 reaches the limit of travel, the projection 123 will be unable to drive the grip portion 71 of the inhaler 10 any further. However, since the ring 121 is made of resilient material, further rotation of the ring 121 will cause the projection 123 to be pushed outwardly away from the grip portion 71 of the inhaler 10, over the abutting flank 127 and into an adjacent groove 125. In this way, the ring 121 is able to rotate relative to the grip portion 71 of the inhaler 10 and ensure complete rotation of the dispersion chamber 5.

The ring 121 is mounted in a sealing cap 129 which is removably attached to the mounting gear 95. The outer surface of the sealing cap 129 includes a short male thread 131 which is received by a corresponding female thread 132 formed in an inner surface of the mounting

gear 95, whereby in use the sealing cap 129 is screwed into the mounting gear 95. The sealing cap 129 further includes an elongate spring plate 133 which extends diametrically across the base thereof. The ends 134 of the spring plate extend beyond the circumference of the sealing cap 129 and are configured to engage in corresponding cut-outs 135 in the mounting gear 95. The spring plate 133 thus prevents relative rotation between the sealing cap 129 and the mounting gear 95 when the sealing cap 129 is fully screwed into the mounting gear 95. Thus, to load the inhaler 10 into the inhalation device, the sealing cap 129 is rotated relative to the mounting gear 95, during which time the spring plate 133 is temporarily deformed, and the sealing cap 129 is unscrewed. Then, after locating the grip portion 71 of the inhaler 10 in the ring 121, the inhaler 10 is inserted into the cavity 63 and the sealing cap 129 is screwed into the mounting gear 95 until the ends 134 of the spring plate 133 locate in the cut-outs 135 in the mounting gear 95 and the sealing cap 129 is secured in place.

The ring 121 includes apertures 137 in one half of the circumference which are engaged by hooks or teeth (not illustrated) that extend radially inwardly from an inner surface of the sealing cap 129 and hold that side of the ring 121 fixedly to the sealing cap 129. The ring 121 also includes a radially inwardly-directed tag 139 at one edge in the other half of the circumference. The tag 139 includes a hole 141 which locates with a pin (not illustrated) provided in the bottom of the sealing cap 129. The pin is deformable such that on deformation the pin grips the tag 139 and secures the ring 121 within the sealing cap 129. Typically, the sealing cap 129 is made of a thermoplastic material, and the pin will be thermally melted. It will of course be appreciated that other arrangements may be used to fix the ring 121 in the sealing cap 129. In particular, in relation to the described arrangement, it will be understood that any number of apertures and tags could be employed and that the apertures and tags could disposed in any suitable position. For example, it is possible to provide one or more hooks which engage the top edge of the ring 121 rather than apertures 137 in the circumference.

The inhalation device further comprises a mechanism for developing the volume of the suction chamber 53. The mechanism comprises the wall member 41 of the accumulation

prevention means mounted to the bottom of the dispersion chamber 5, the piston assembly 59 and biasing means 143, in this embodiment a compression spring, which is arranged to axially bias the wall member 41 and the piston assembly 53 apart.

The wall member 41 of the accumulation prevention means is made of a material, such as a metal, which can withstand the biasing force of the biasing means 143, and includes a central slot 48, through which extends the lower part of passageway 44, and an opening 58 through which extends an upwardly-directed elongate component 149 of the piston assembly 59. The wall member 41 includes first, second and third downwardly depending hooks 151 and first, second and third radially outwardly directed flanges 153 which, in this embodiment, are equi-spaced about the circumference. The downwardly-depending hooks 151 are provided to engage the piston assembly 59 as will be described hereinbelow. The radial flanges 153 are provided to help guide movement of the dispersion chamber 5 within the cavity 3. In this embodiment each of the flanges 153 are encompassed by a ring 155 of a material which is mechanically softer and has a lower coefficient of resistance than that of the material of the wall member 41, whereby damage to the internal surface of the wall of the cavity 3 is reduced.

The piston assembly 59 comprises a piston base 118, to which the one or more seals 61 are fitted, and a catch plate 159. The catch plate 159 includes first, second and third radially outwardly directed flanges 161 which are arranged to engage respectively with the first, second and third hooks 151 of the wall member 41. The catch plate 159 is coupled to the piston base 118 so as to be rotatable relative to the piston base 118 through a small angle about the longitudinal axis of the suction chamber 53. The piston assembly 59 includes a further biasing means 163, in this embodiment a tension spring, which is connected to the piston base 118 and the catch plate 159 so as to bias the catch plate 159 rotationally relative to the piston base 118 in the same sense that the wall member 41 and piston base 118 are rotated to disengage the flanges 161 of the catch plate 159 from the hooks 151 of the wall member 41.

In the closed position, as illustrated in Figure 1, the flanges 161 of the catch plate 159 are engaged by the hooks 151 of the wall section 41. Thus, as the dispersion chamber 5 is withdrawn from the housing 1, the catch plate 159 and the piston base 118 of the piston assembly 59 are raised together with the wall section 41. When the dispersion chamber 5 is rotated, in this embodiment in the counter clockwise sense when viewed from above, towards the operative position, as illustrated in Figure 3, the elongate member 49 rotates the catch plate 159 and the piston base 118 of the piston assembly 59 at least initially concomitantly with the dispersion chamber 5. However, just before the point of complete rotation of the dispersion chamber 5 is reached the first, second and third flanges 161 of the catch plate 159 each engage with projections (not illustrated) which are located on the inner surface of the wall defining the cavity 3. At this point, the catch plate 159 is rotationally fixed by the projections, and the dispersion chamber 5 and the piston base 118 continue to rotate relative to the catch plate 157. With continued rotation, the hooks 151 of the wall section 41 are disengaged from the flanges 161 of the catch plate 157. At the point of disengagement, which corresponds to the rotational position where the dispersion chamber 5 has been rotated fully to the operative position and the dosing mechanism of the inhaler 10 has been operated, the piston base 118 is released and is driven, under the action of the biasing means 143, to the bottom of the cavity 3, thereby increasing the volume of the suction chamber 53. When the dispersion chamber 5 is rotated back, in this embodiment in the clockwise sense when viewed from above, to the position with the mouthpiece 17 located above the housing 1, as illustrated in Figure 4, and then pushed into the housing 1 to the closed position, as illustrated in Figure 1, the biasing means 143 is compressed and the hooks 159 on the wall member 41 engage the flanges 161 on the catch plate 159. In this position the inhalation device is ready for further use. It will be understood that the release mechanism of the inhalation device is such as to release the piston assembly 59 reliably and automatically without any special action being required by the user and that the piston assembly 59 is automatically reset on returning the device to the closed position.

In this embodiment the upper part 13 of the dispersion chamber 5 includes an insert 165 fitted thereto. The insert 165 provides an indication of the kind of substance which should be dispensed by the device. The insert 165 is preferably of a colour specific to the

substance to be dispensed. In this way, the user need only check that the colour associated with the inhaler 10 is the same as the colour associated with the inhalation device. This comparison can be made quickly without any detailed examination and without knowing what substance the specific colour signifies. By ensuring that the colours associated with the inhalation device and the inhaler 10 are always the same, the user can prevent the inhalation device ever being used with a different substance and, therefore, prevent cross-contamination. The insert 165 is preferably resiliently clipped in place or adhesively mounted to the upper part 13 of the dispersion chamber 5 so as to be extremely difficult, if not impossible, to remove without itself being broken or breaking the inhalation device. It will be understood that an insert could be provided to other parts of the inhalation device. Alternatively, a part of the inhalation device, such as the dispersion chamber 5 or the base of the housing 1, or indeed the entire inhalation device, could be coloured appropriately.

In a preferred embodiment all of or part of the outer walls defining the cavity 63 and/or the sealing cap 129 are formed from a transparent or translucent material. In this way, when the inhaler 10 includes an indication of the contained substance, such as by colouring of the grip portion 71 of the inhaler 10, a user may be able to determine immediately the substance contained by the inhalation device without needing to dismantle the device. In addition, the inhalation device may also be used with an inhaler which includes a dose counter. By making the walls, or at least an appropriate part of those walls, defining the cavity 63 transparent or translucent, or providing a window corresponding in size to that of the inhaler, a user may easily see when the inhaler has reached the end of its useful life. The inhalation device itself thus need not incorporate a counting mechanism. However, where the inhalation device is provided with a window it is necessary to provide some means of ensuring that the inhalation device is inserted correctly such that the dose counter is aligned with the window in the inhalation device.

In use, an inhaler 10 is first fitted in the cavity 63 in the housing 1. The dispersion chamber 5 is then telescopically extended from the housing 1 to the position illustrated in Figure 2. As illustrated in Figure 2, the piston assembly 59 travels with the dispersion chamber 5. From the position illustrated in Figure 2, the dispersion chamber 5 is then

rotated through an angle of approximately 90° in one sense, in this embodiment in the counter-clockwise sense when viewed from above. This rotational movement is transferred to the grip portion 71 of the inhaler 10 such that a dose of powder is provided to the inhalation channel of the inhaler 10. Once the dispersion chamber 5 reaches the position illustrated in Figure 3, the latch mechanism acts to release the piston assembly 59 from engagement with the dispersion chamber 5. As a result, the biasing means 143 drives the piston assembly 59 down to the bottom of the housing 1 so as to expand the volume of the suction chamber 53. This expansion of the volume of the suction chamber 53 causes powder to be drawn from the inhaler 10 and into the dispersion chamber 5 through the channel 67. In this embodiment the piston base 118 includes an upstanding member 149 of conical section which is movably disposed within the passageway 55 extending upwardly of the lower wall section 11 of the dispersion chamber 5. The upstanding member 149 acts as a flow regulating valve, with the space between the upstanding member 149 and the passageway 55 increasing as the piston assembly 59 moves to the bottom of the housing 1. This flow regulating valve compensates for the non-linear characteristics of the biasing means 143 so as to provide that the flow characteristics of the air drawn into the dispersion chamber 5 are optimal. The user may then inhale the powder dispersed in the dispersion chamber 5 by sucking on the mouthpiece 17 provided thereto. Figure 4 illustrates the inhalation device with the piston assembly 59 located at the bottom of the housing 1, but with the dispersion chamber 5 rotated back, in this embodiment in the clockwise sense when viewed from above, through an angle of approximately 90°. From this position the dispersion chamber 5 is pushed telescopically back into the housing 1 to the position illustrated in Figure 1.

Finally, it will be understood by a person skilled in the art that the present invention has been described in its preferred embodiment and can be modified in many different ways without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. An inhalation device for providing, in a dispersed state, a substance obtained from a dosing mechanism which provides a dose of said substance when moved from a first to a second position, the device comprising:
a housing;
a component movable relative to the housing between a storage position and an operative position; and
a drive mechanism for transferring movement of the component to the dosing mechanism;
wherein the drive mechanism comprises a slip clutch which allows relative movement between the component and the dosing mechanism when a resistance to movement of the dosing mechanism exceeds a threshold higher than the resistance to movement of the dosing mechanism from the first to the second position.

2. The inhalation device according to claim 1, wherein the component comprises a mouthpiece through which said substance may be inhaled.

3. The inhalation device according to claim 1 or 2, wherein the component comprises a dispersion chamber for containing said substance in a dispersed state.

4. The inhalation device according to claim 3, wherein the dispersion chamber includes an inlet for receiving said substance and the housing comprises a channel for ducting said substance to the inlet, the inlet only being aligned with the channel when the component is in the operable position.

5. The inhalation device according to any of claims 1 to 4 for use with an inhaler comprising the dosing mechanism, the dosing mechanism being operable to prepare a dose of substance for inhalation and comprising a manoeuvring portion by which the dosing mechanism may be operated, the device comprising a section for receiving the

inhaler such that the drive mechanism is operably connected to the manoeuvring portion.

6. The inhalation device according to claim 5 for use with an inhaler having a rotatable manoeuvring portion with a substantially circular outer periphery, wherein the slip clutch comprises an annular member for receiving and resiliently gripping the outer periphery of the manoeuvring portion.

7. The inhalation device according to claim 6 for use with an inhaler having a manoeuvring portion with a ribbed outer periphery, wherein the slip clutch comprises at least one radially inwardly extending resilient portion for fitting between adjacent ribs of the manoeuvring portion.

8. The inhalation device according to claim 6 or 7, wherein the slip clutch is constructed as a shaped band of resilient material.

9. The inhalation device according to claim 8, wherein the drive mechanism includes a rotatable part onto which the slip clutch is mounted.

10. The inhalation device according to claim 9, wherein the rotatable part has at least one hook for securing the shaped band.

11. The inhalation device according to claim 9 or 10, wherein the shaped band has at least one substantially radially extending flange with edges defining a hole therein and the rotatable part has a pin extending through the hole, the pin being deformed so as to be secured within the hole.

12. The inhalation device according to any of claims 8 to 11, wherein the resilient material is spring steel.

13. A method of operating a dosing mechanism with a movable component of an inhalation device so as to provide a dose of substance in the inhalation device, the method comprising the steps of:

providing a drive mechanism between the component and the dosing mechanism, the drive mechanism being arranged to move the dosing mechanism further than required to provide said dose when the component is moved from a storage position to an operative position; and

providing a slip clutch between the component and the dosing mechanism, the slip clutch allowing relative movement between the component and the dosing mechanism when a resistance to movement of the dosing mechanism exceeds a threshold higher than the force required to move the dosing mechanism to the position required to provide said dose such that the component may continue to move to the operative position.

14. An inhalation device for containing a substance in a dispersed state, comprising:

a dispersion chamber having walls for containing a substance in a dispersed state, wherein at least one of the walls includes edges defining a plurality of apertures through the at least one of the walls, each of the apertures allowing said substance to leave the dispersion chamber more easily than to enter the dispersion chamber.

15. The inhalation device according to claim 14, wherein the edges defining the apertures extend from an inner surface to an outer surface of the at least one wall and are shaped such that the apertures are smaller at the outer surface than at the inner surface.

16. The inhalation device according to claim 15, wherein the edges are shaped such that the apertures taper inwardly from the inner surface to the outer surface of the at least one wall.

17. The inhalation device according to any of claims 14 to 16, wherein the edges define apertures having an elongate slot form.

18. The inhalation device according to any of claims 14 to 17, wherein the minimum distance between the edges defining a respective one of the apertures is between 0.3mm and 0.7mm.

19. The inhalation device according to claim 18, wherein the minimum distance is in the region of 0.5mm.

20. The inhalation device according to any of claims 14 to 19, wherein a secondary wall is provided outside the dispersion chamber, the at least one of the walls and the secondary wall together defining a collection chamber for collecting said substance which has left the dispersion chamber through the apertures.

21. The inhalation device according to any of claims 14 to 20, further comprising a housing for supporting the dispersion chamber, the housing including a base on which to stand the inhalation device, the at least one of the walls being provided at the bottom of the dispersion chamber relative to the orientation of the inhalation device when stood on the base.

22. A method of preventing accumulation of substance in a dispersion chamber, comprising the steps of:
providing one or more apertures through the thickness of at least one wall of the dispersion chamber; and
shaping and sizing the apertures so as to allow more easily the substance to leave the dispersion chamber than to enter the dispersion chamber.

23. The method according to claim 22, wherein the apertures are shaped so as to taper inwardly towards the outside of the at least one wall.

24. An inhalation device for providing a substance in a dispersed state, comprising:
a housing;

a component movable relative to the housing between a storage position and an operative position, the component having a peripheral surface defining an aperture and a closed surface adjoining the peripheral surface;

a channel for ducting said substance, the channel defining an opening adjacent the component, the opening being aligned with the aperture when the component is in the operative position and opposite the closed surface when the component is in the storage position; and

a sealing member having a sealing surface for providing a seal between the opening and both the closed surface and the peripheral surface;

wherein the sealing member is provided with at least one protrusion extending beyond the sealing surface and, at both the storage and operative positions, the closed surface and the peripheral surface is provided with at least one recess corresponding to the at least one protrusion such that the sealing surface seals with the closed surface when the component is in the storage position and seals with the peripheral surface when the component is in the operative position, but is held away from the closed surface and the peripheral surface by the at least one protrusion for any position intermediate the operative position and the storage position.

25. The inhalation device according to claim 24, wherein the component comprises a dispersion chamber for containing said substance in a dispersed state and which moves axially and rotationally relative to the housing between the operative and storage positions, the dispersion chamber having an outer cylindrical surface comprising the closed and peripheral surfaces.

26. The inhalation device according to claim 24 or 25, wherein the channel is in fluid connection with a chamber from which a dose of said substance may be provided and is for ducting said dose to the component.

27. The inhalation device according to any of claims 24 to 26, wherein the sealing member comprises an axially extendable portion for joining the sealing surface to the channel

and a resilient member for biasing the sealing surface against the peripheral and closed surfaces of the component.

28. The inhalation device according to claim 27, further comprising a mechanism for controlling the resilient member such that the resilient member only biases the sealing surface when the component is in one of the operative position and the storage position.

29. The inhalation device according to any of claims 24 to 28, wherein the at least one protrusion is positioned relative to the aperture such that upon movement of the component between the operative and storage positions, the at least one protrusion does not traverse the aperture.

30. The inhalation device according to any of claims 24 to 29, wherein the at least one protrusion comprises at least two protrusions diametrically opposed with regard to the opening.

31. A method of sealing an opening of a feed channel to a moveable component, the moveable component having a peripheral surface defining an aperture and a closed surface adjoining the peripheral surface, the method comprising the steps of:
providing a sealing member with a sealing surface for sealing between the opening and both the closed surface and the peripheral surface;
providing on the sealing member at least one protrusion extending beyond the sealing surface;
providing in both a predetermined position of the closed surface and the peripheral surface at least one recess corresponding to the at least one protrusion such that the sealing surface seals with the closed surface at the predetermined position and with the peripheral surface when the opening is aligned with the aperture, but is held away from the closed surface and the peripheral surface by the at least one protrusion for any intermediate position.

32. An inhalation device for providing a substance in a dispersed state, comprising:

a housing;

a dispersion chamber having walls for containing a substance in a dispersed state, the dispersion chamber being mounted in the housing so as to be axially and rotatably movable;

a mechanism for providing said substance for dispersion; and

an elongate member for transferring rotational movement of the dispersion chamber to the mechanism;

wherein the dispersion chamber includes an enclosed passageway extending axially inwardly of the dispersion chamber from one of the walls, the elongate member being axially movable into and out of said passageway through the one of the walls.

33. The inhalation device according to claim 32, wherein the internal cross-section of the passageway is greater than the external cross-section of the elongate member such that a gap is left between the outer surface of the elongate member and the inner surface of the passageway, protrusions being formed on the inner surface of the passageway so as to fix the elongate member rotationally relative to the passageway.

34. The inhalation device according to claim 32 or 33, wherein the elongate member comprises an elongate plate.

35. The inhalation device according to claim 34, wherein the elongate plate is made of metal.

36. The inhalation device according to any of claims 32 to 35, wherein one of walls of the dispersion chamber defines an opening through which substance may be ducted thereinto, the external cross-section of the passageway having an extent greater in a first direction than a second direction parallel to the first direction and the passageway being orientated relative to the opening such that the first direction is substantially parallel to the direction in which substance enters the dispersion chamber through the opening.

37. The inhalation device according to claim 36, wherein the extent in the first direction is at least three times the extent in the second direction.

38. The inhalation device according to claim 36 or 37, wherein the extent in the second direction tapers inwardly towards each end of the extent in the first direction.

39. The inhalation device according to any of claims 32 to 38, wherein the enclosed passageway is formed from two halves, one of the two halves being formed integrally with the one of the walls.

40. The inhalation device according to claim 39, wherein an insert is provided in the dispersion chamber, the insert forming a wall of the dispersion chamber opposite one of the walls, defining an outlet aperture and forming a channel-shaped region around the outlet aperture, the other of the two halves being formed integrally with the insert.

41. The inhalation device according to claim 40, further comprising a suction channel passing through the one of the walls and the insert, the suction channel being formed from two halves, one of the two halves being formed integrally with the one of the walls and the other of the two halves being formed integrally with the insert.

42. A method of transferring rotational movement of the dispersion chamber of an inhalation device to a mechanism for providing a substance for dispersion in the dispersion chamber, the method comprising the steps of:
providing an elongate member axially of the dispersion chamber for transferring rotation of the dispersion chamber to the mechanism; and
providing an enclosed passageway extending axially inwardly of the dispersion chamber from one of the walls defining the dispersion chamber, the elongate member being axially movable into and out of the passageway through the one of the walls.

43. An inhalation device for containing in a dispersed state a substance provided from an inhaler having an outer surface with an indication of a state of the inhaler, the device comprising a housing having a chamber for receiving the inhaler, wherein the housing comprises a portion through which the indication on the inhaler may be viewed by the user.

44. The inhalation device according to claim 43, wherein the portion comprises a transparent window.

45. The inhalation device according to claim 43 or 44, wherein the portion comprises a translucent window.

46. The inhalation device according to any of claims 43 to 45, wherein the indication includes an indication of the type of substance dispensed by the inhaler.

47. The inhalation device according to claim 46, wherein the indication on the inhaler is provided by the colour of at least a part of the inhaler.

48. The inhalation device according to claim 47, further comprising a removable member for closing the chamber and securing an inhaler within the chamber, the colour of the removable member being used to indicate the type of substance to be contained in the inhalation device.

49. The inhalation device according to claim 46, further comprising a removable member for closing the chamber and securing an inhaler within the chamber.

50. The inhalation device according to claim 48 or 49, wherein the removable member comprises the portion.

51. The inhalation device according to any of claims 46 to 50, further comprising an insert provided on an outer surface of the inhalation device, the insert providing an indication of the type of substance to be contained in the inhalation device.

52. The inhalation device according to any of claims 43 to 51, wherein the indication includes an indication of the number of doses dispensed or remaining in the inhaler.

53. The inhalation device according to claim 52, wherein at least a part of the chamber comprises the portion.

54. The inhalation device according to any of claims 46 to 53 in combination with an inhaler having an outer surface with an indication of a state of the inhaler.

55. A method of indicating to a user a state of an inhaler housed in an inhalation device for containing in a dispersed state a substance provided from the inhaler, the method comprising the step of:
providing a portion in the inhalation device through which an indication of the state of the inhaler provided on the inhaler may be viewed by the user.

56. The method according to claim 55, wherein the indication of the state of the inhaler includes one or both of an indication of the type of substance dispensed by the inhaler and an indication of the number of doses dispensed or remaining in the inhaler.

57. A method of ensuring that an inhalation device for containing in a dispersed state a substance provided from an inhaler is always used with the same type of substance, the method comprising the steps of:
providing on an outer surface of an inhaler an indication of the type of substance to be dispensed by the inhaler;
providing a portion on the inhalation device through which the indication on the inhaler may be viewed by the user; and

providing on the inhalation device an indication of the type of substance to be contained by the inhalation device.

58. An inhalation device for containing a substance in a dispersed state, comprising:
a suction chamber defined by a cylindrical wall and two end faces movable together rotationally relative to the cylindrical wall and movable axially relative to one another along the cylindrical wall; and
an intermediate component mounted on one of the two end faces and facing the other of the two end faces, the intermediate component being movable relative to the two end faces so as to engage and disengage with the other of the two end faces;
wherein the cylindrical wall is provided with release means for engaging the intermediate component such that, with the intermediate component engaging the other of the two end faces, at a predetermined position in the rotation of the two end faces relative to the cylindrical wall, the release means causes the intermediate component to disengage the other of the two end faces.

59. The inhalation device according to claim 58, wherein the one of the two end faces comprises a piston in the suction chamber.

60. The inhalation device according to claim 58 or 59, wherein the intermediate component is mounted on the one of the two end faces so as to be movable relative to the one of the two end faces rotationally about the axis of the cylindrical wall.

61. The inhalation device according to claim 60, wherein a bias spring is provided to bias the intermediate component to a predetermined position relative to the one of the two end faces.

62. The inhalation device according to claim 60 or 61, wherein the other of the two end faces is provided with at least one hook portion and the intermediate component is provided with at least one flange which is engageable by the hook portion of the other of the two end faces.

63. The inhalation device according to claim 62, wherein the release means engage the at least one flange.

64. The inhalation device according to any of claims 58 to 63, wherein a suction spring is provided to bias the two end faces axially away from one another.

65. The inhalation device according to any of claims 58 to 64, further comprising a dispersion chamber in which said substance is dispersed, the suction chamber being in fluid connection with the dispersion chamber and being arranged to draw air from the dispersion chamber.

66. The inhalation device according to claim 65, wherein the other of the two end faces comprises a wall of the dispersion chamber and the dispersion chamber is movable axially within the cylindrical wall.

67. The inhalation device according to claim 66, wherein the dispersion chamber may be moved from a storage position where it is housed substantially within the cylindrical wall to a position extending out of the cylindrical wall and the one of the two end faces is moved with the dispersion chamber by way of the intermediate component, the release means comprising protrusions provided within the cylindrical wall such that when the dispersion chamber is rotated in its extended position to an operative position, the protrusions engage the intermediate component immediately prior to the dispersion chamber reaching its operative position such that the one of the two end faces and the intermediate component are released from the dispersion chamber and moved axially along the cylindrical wall away from the dispersion chamber so as to expand the suction chamber.

68. A method of engaging and releasing from one another two end faces which, together with a cylindrical wall, define a suction chamber, the two end faces being movable

together rotationally relative to the cylindrical wall and movable axially relative to one another along the cylindrical wall, the method comprising the steps of:

mounting an intermediate component on one of the two end faces so as to face the other of the two end faces and mounting the intermediate component so as to be movable relative to the two end faces so as to engage and disengage with the other of the two end faces; and

providing the cylindrical wall with release means for engaging the intermediate component such that, with the intermediate component engaging the other of the two end faces, at a predetermined position in the rotation of the two end faces relative to the cylindrical wall, the release means causes the intermediate component to disengage the other of the two end faces.

69. An inhalation device for containing a substance in a dispersed state, comprising:

a portion for receiving an inhaler having a manoeuvring means for operating a dosing mechanism to release a dose of said substance; and

a component adjacent the portion for moving the manoeuvring means;

wherein movement of the component to move the manoeuvring means also selectively opens and closes an air path of the inhalation device.

70. The inhalation device according to claim 69, wherein the portion comprises a chamber for housing an inhaler and the component is positioned at one end of chamber.

71. The inhalation device according to claim 70, wherein movement of the component opens and closes an air opening to the chamber.

72. The inhalation device according to claim 71, wherein the manoeuvring means is rotatable to release a dose of the substance and the component is a rotatable component provided at one end of the chamber for rotating the manoeuvring means, the rotatable component moving axially of the chamber with relative rotation and the axial movement selectively opening and closing the opening to the chamber.

73. The inhalation device according to claim 72, wherein the rotatable component comprises a cap into which the manoeuvring means of the inhaler may be fitted.

74. The inhalation device according to claim 73, wherein the cap comprises a resilient component for gripping the manoeuvring means of the inhaler.

75. The inhalation device according to any of claims 72 to 74, wherein the rotatable component comprises a removable portion which, when removed, exposes an aperture in the rotatable component through which an inhaler may be inserted.

76. The inhalation device according to any of claims 72 to 75, wherein the rotatable component has a cylindrical periphery about which are formed a series of radial teeth and a thread, the inhalation device further comprising a toothed gear for driving the radial teeth of the rotatable component so as to rotate the rotatable component, the chamber having a wall with a corresponding thread engaging the thread of the rotatable component such that, with rotation, the rotatable component additionally moves axially of the chamber.

77. The inhalation device according to any of claims 72 to 76, further comprising an external part which is movable between a storage position and an operative position and means for transferring movement of the external part to the rotatable component such that, when the external part is moved from the storage position to the operative position, the rotatable component rotates the manoeuvring means of a fitted inhaler to release a dose of substance and moves axially so as to open the opening to the chamber.

78. A method of selectively opening an air path of an inhalation device, the air path being for allowing air through an inhaler housed in the inhalation device, the method comprising the steps of:

providing a component for moving the manoeuvring means of an inhaler held in the inhalation device for releasing a dose of substance; and

mounting the component in the inhalation device such that as the component moves the manoeuvring means of the inhaler, the component additionally opens the air path of the inhalation device.

79. An inhalation device comprising one or more features from at least two of the groups of claims 1 to 12, 14 to 21, 24 to 30, 32 to 41, 43 to 54, 58 to 67 and 69 to 77.

80. A method combining the steps of at least two of the claims or groups of claims 13, 22 and 23, 31, 42, 55 to 57, 68 and 78.

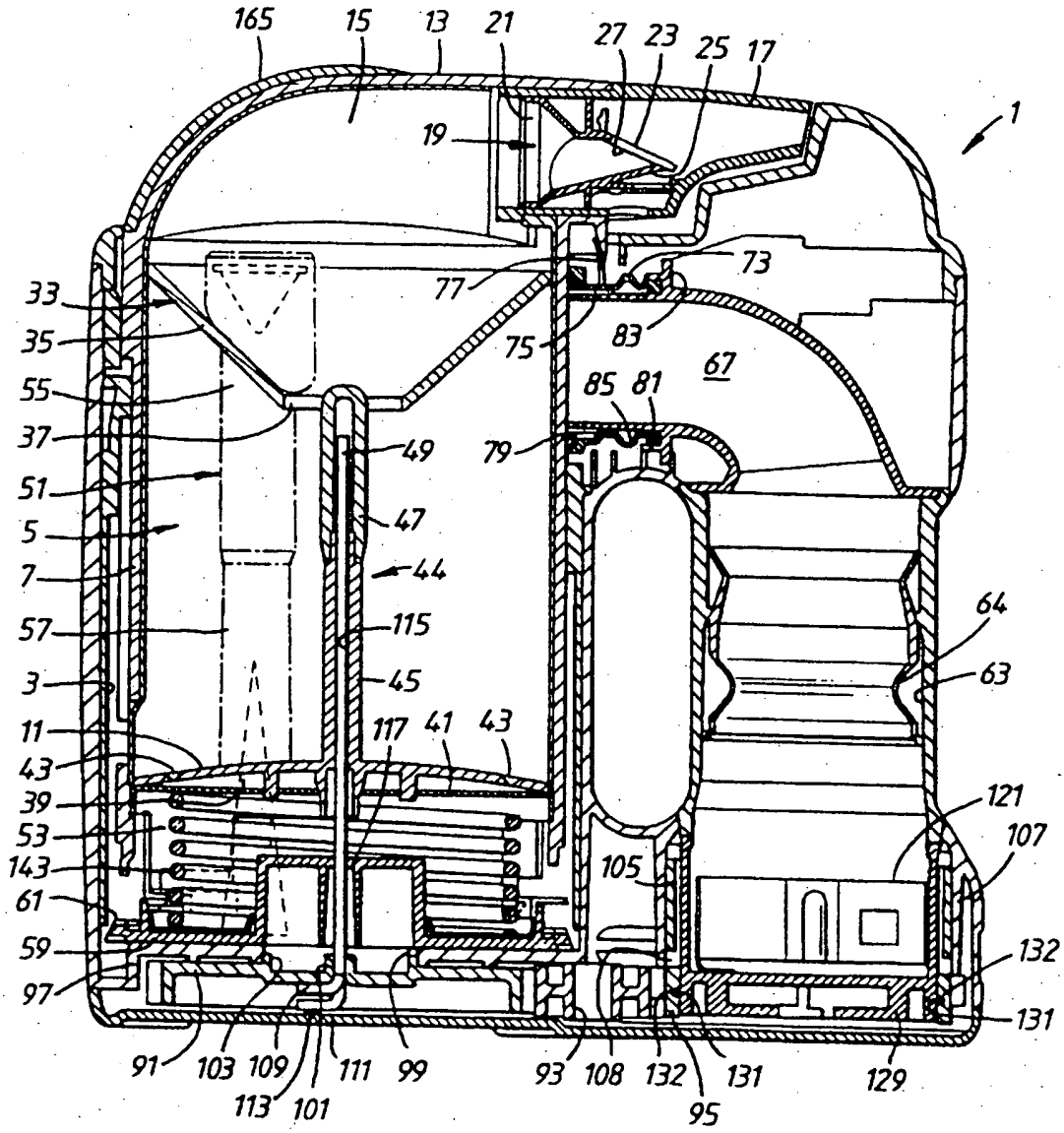
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Fig.1

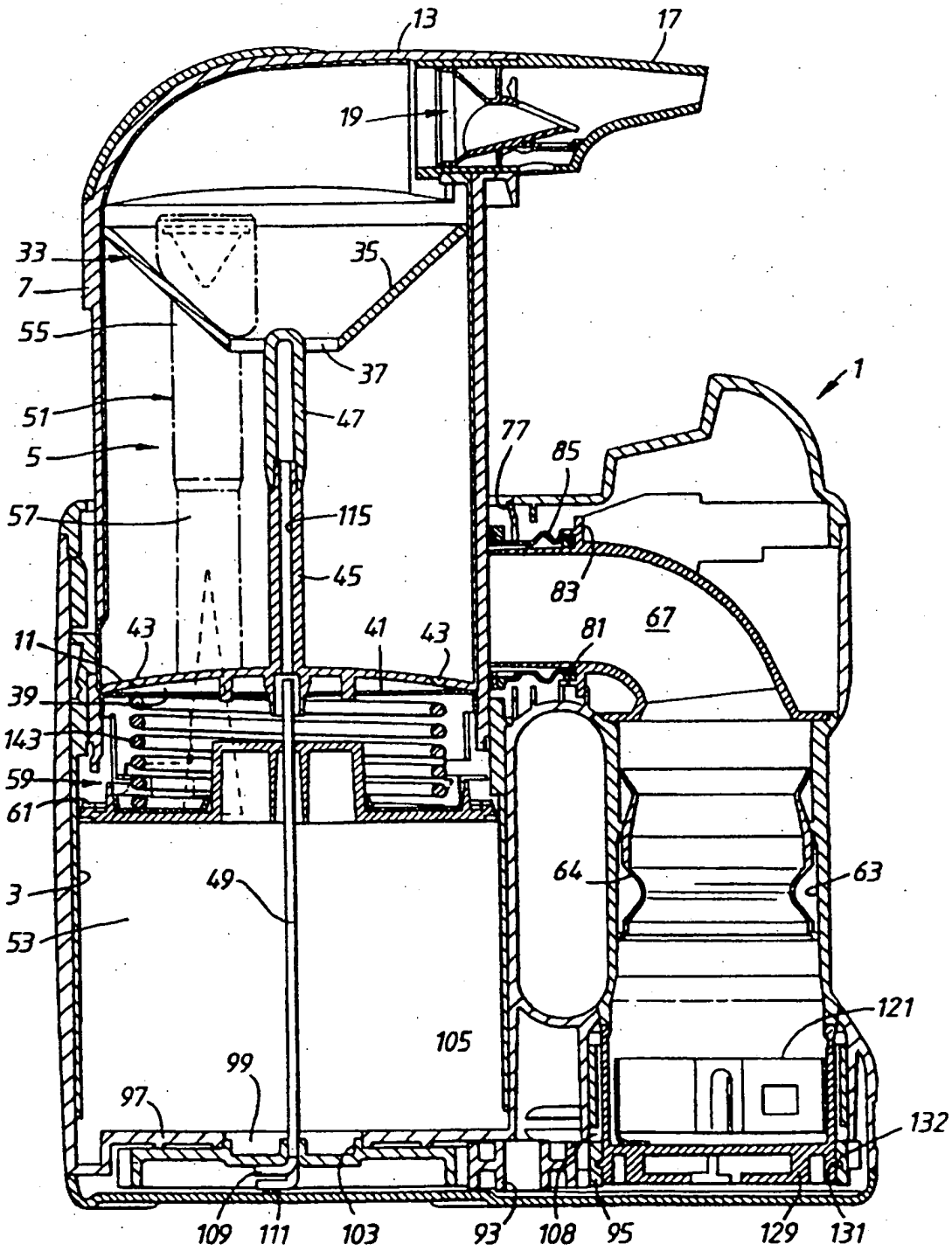
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Fig. 2

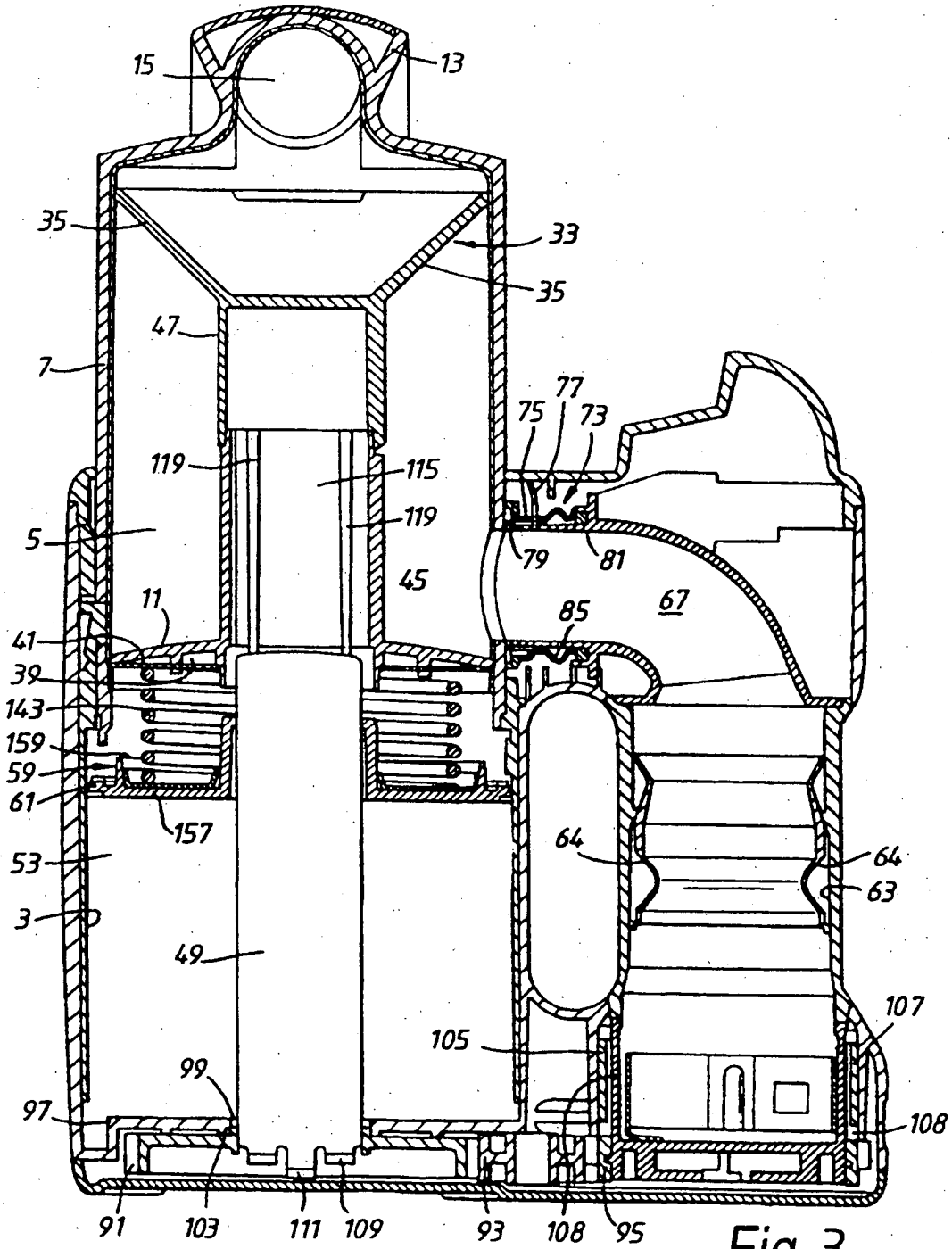
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Fig.3

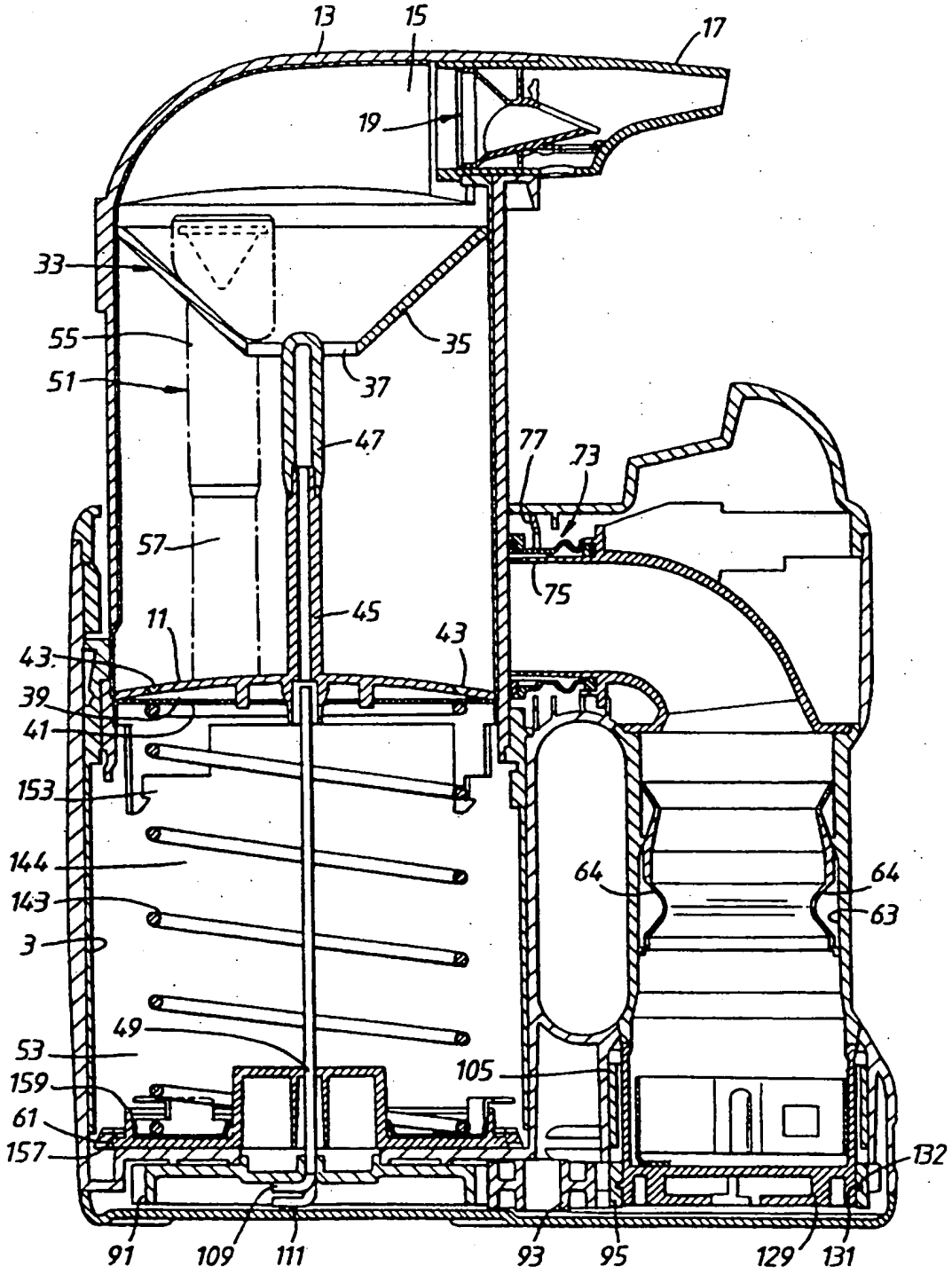
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Fig. 4

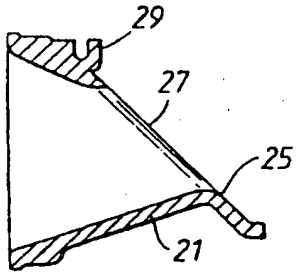



Fig.5(a)

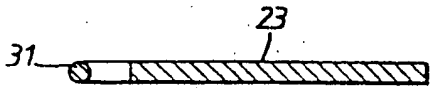



Fig.5(b)

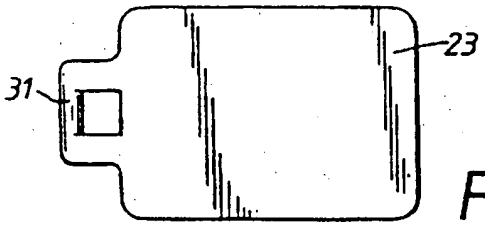



Fig.5(c)

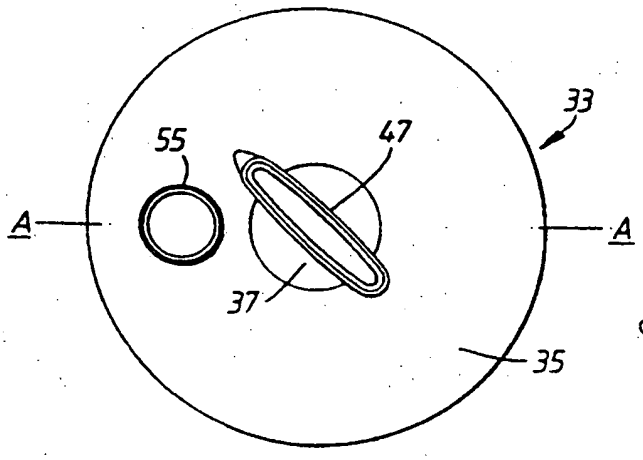



Fig.6(a)

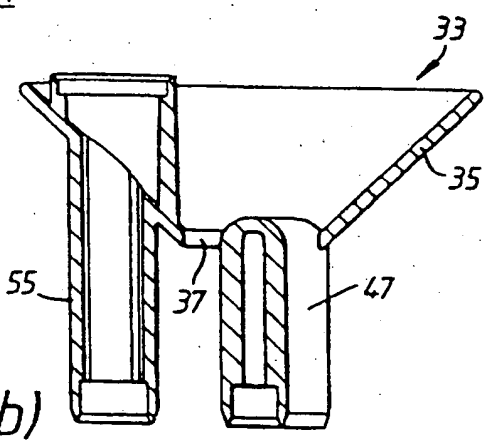



Fig.6(b)

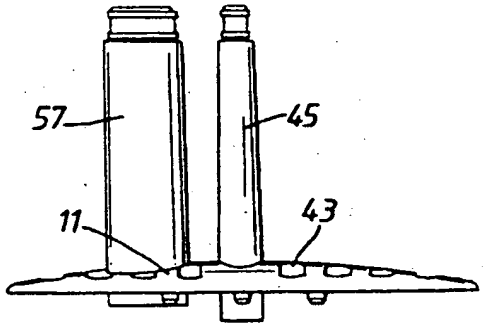



Fig.7(a)

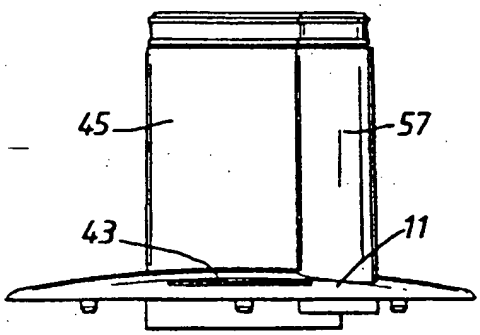



Fig.7(b)

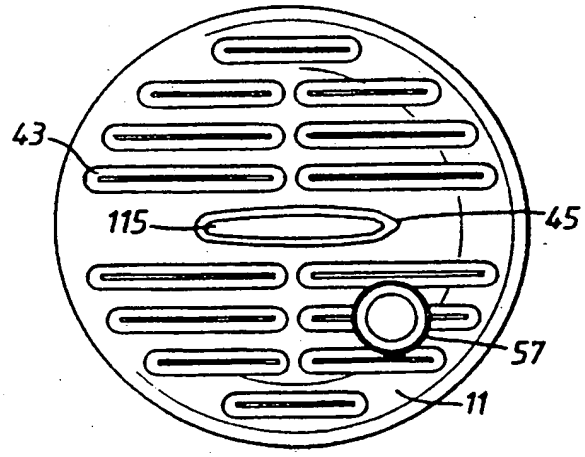



Fig.7(c)


Fig.7(d)

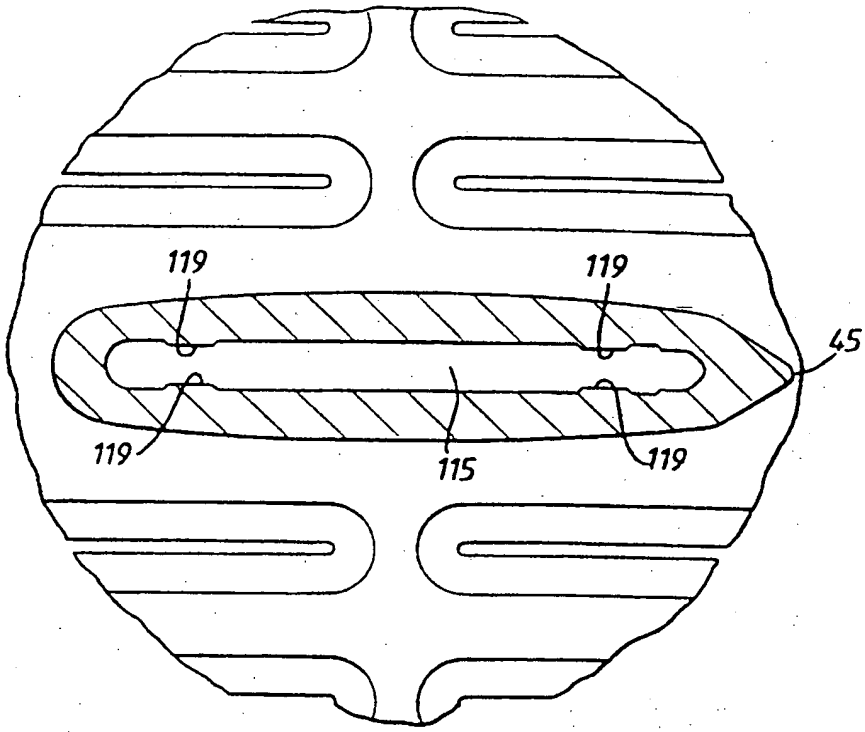



Fig.8

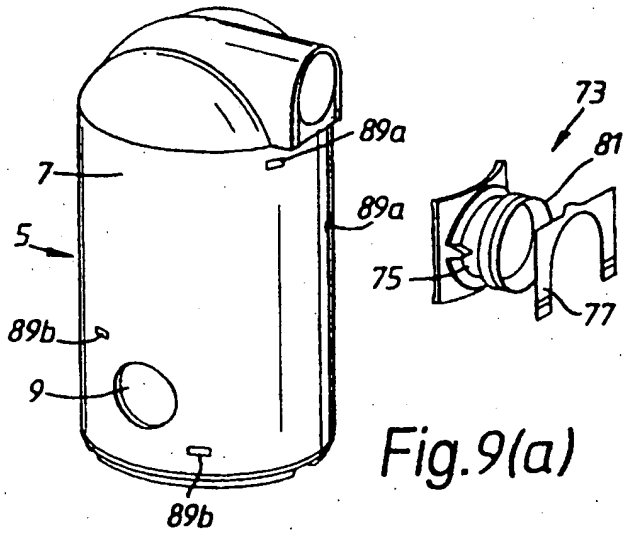



Fig.9(a)

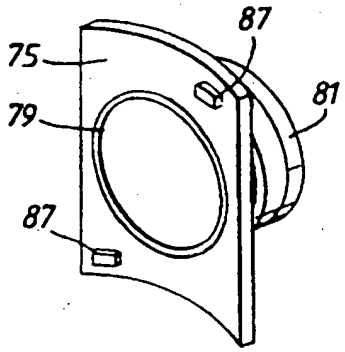



Fig.9(b)

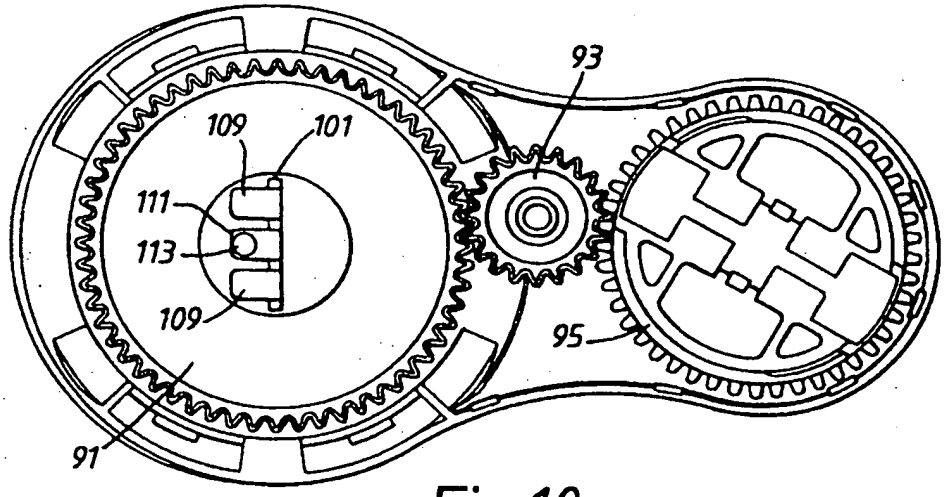



Fig.10

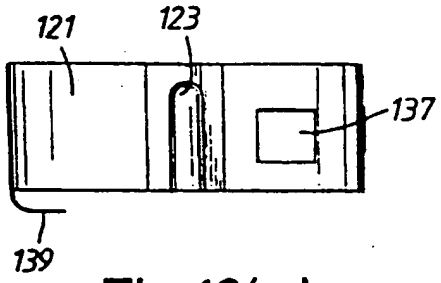
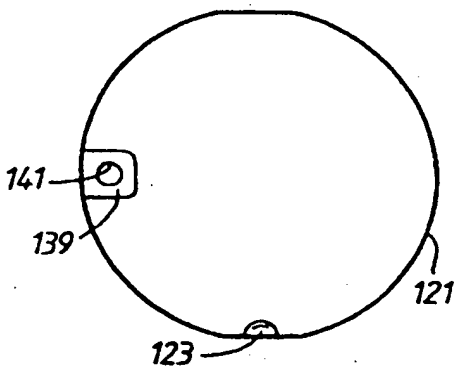



Fig.12(a)

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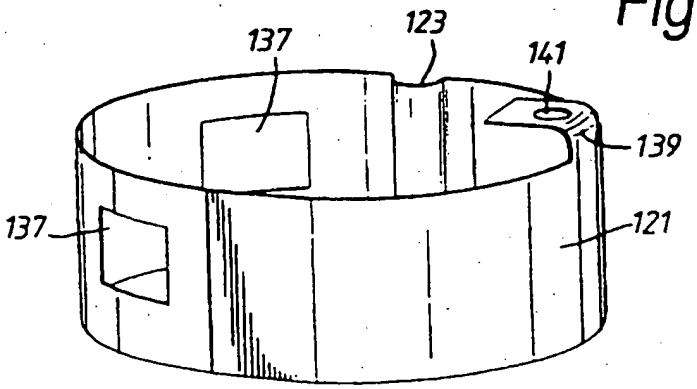


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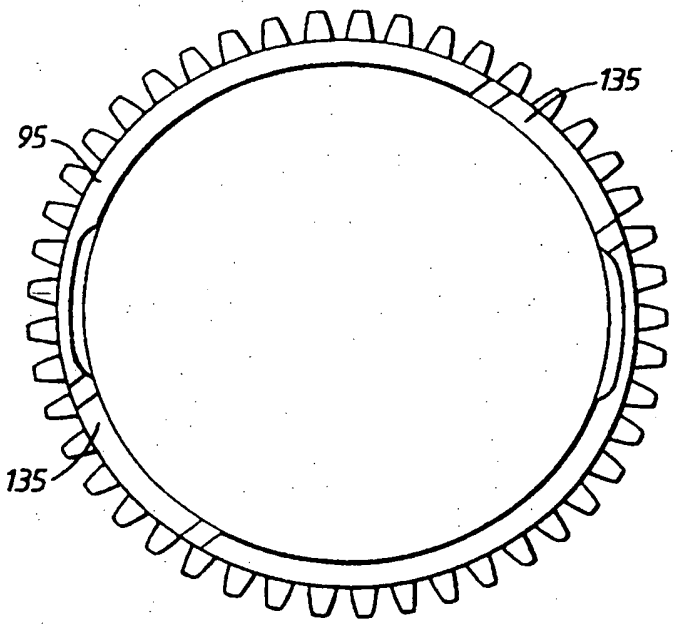


Fig.11(a)

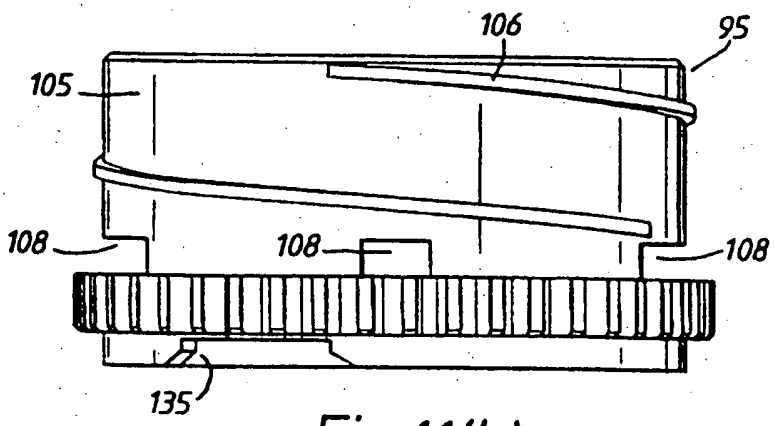


Fig.11(b)

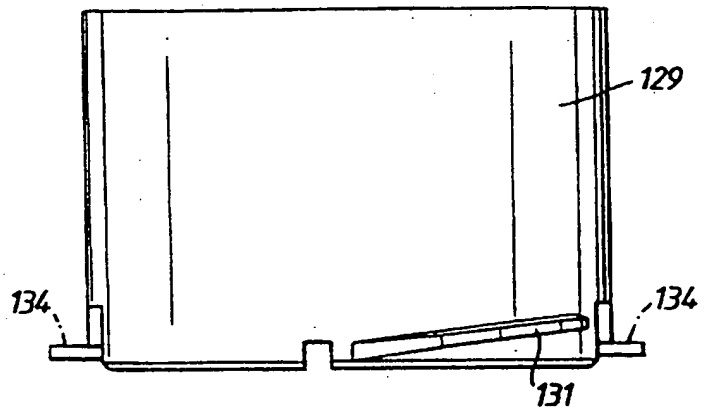


Fig. 13(a)

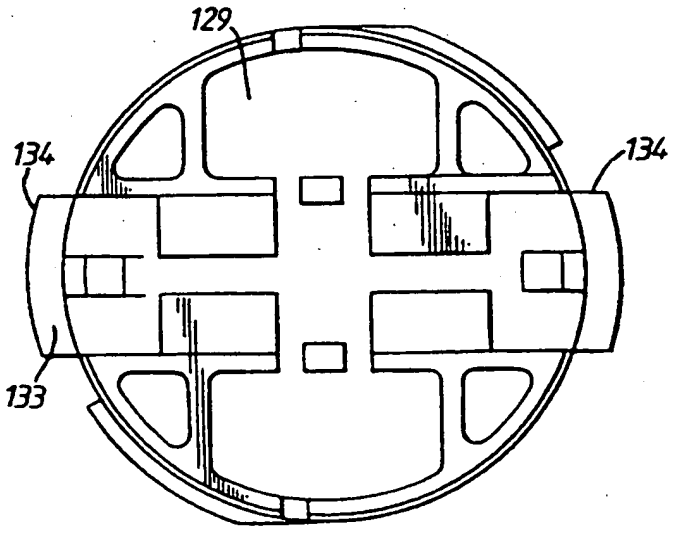


Fig. 13(b)

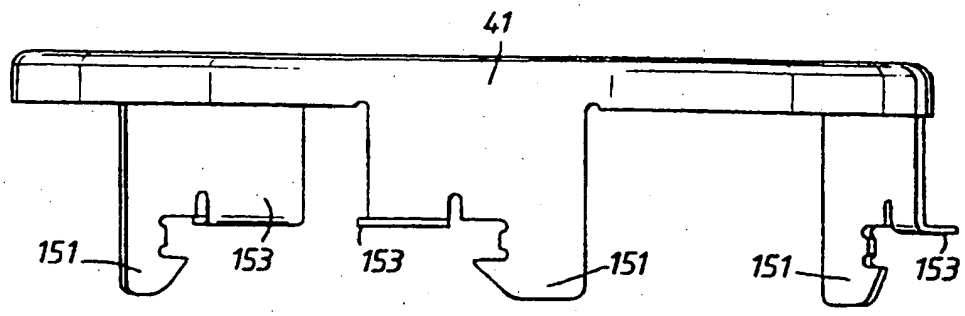


Fig. 14

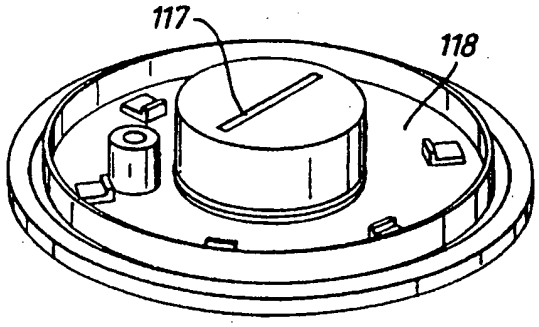


Fig. 15

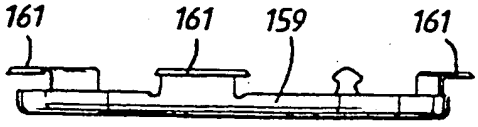


Fig. 16(a)

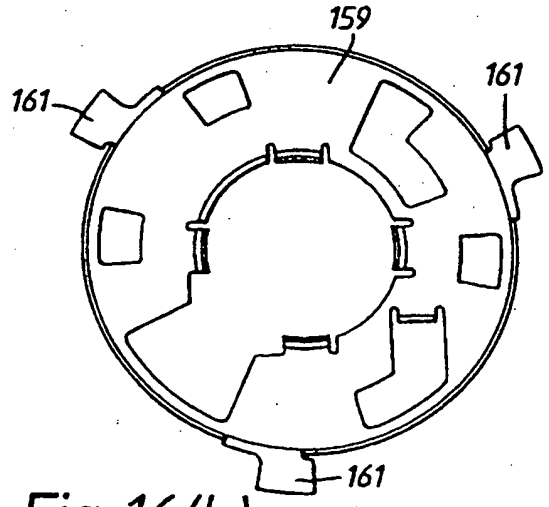


Fig. 16(b)

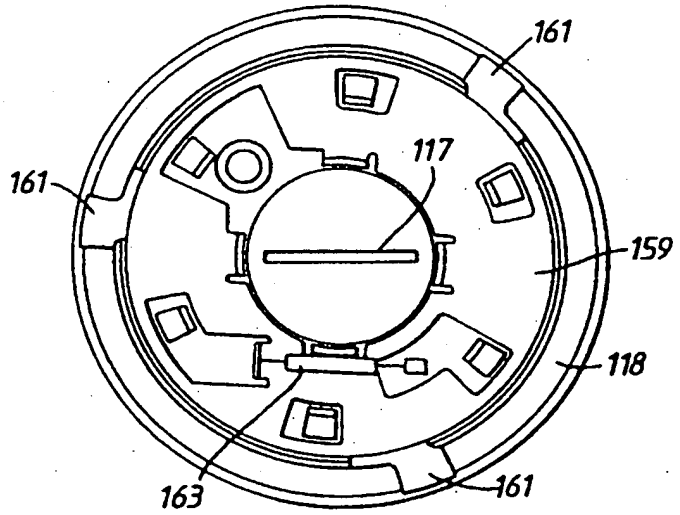
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Fig. 17

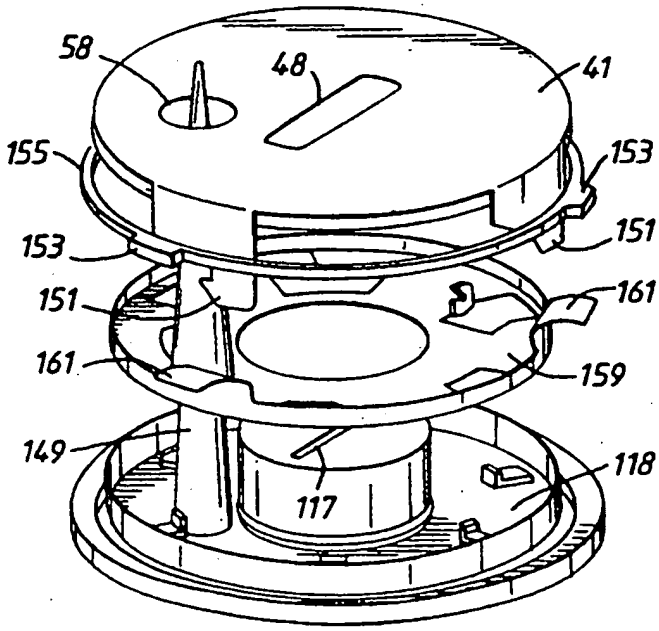
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Fig. 18

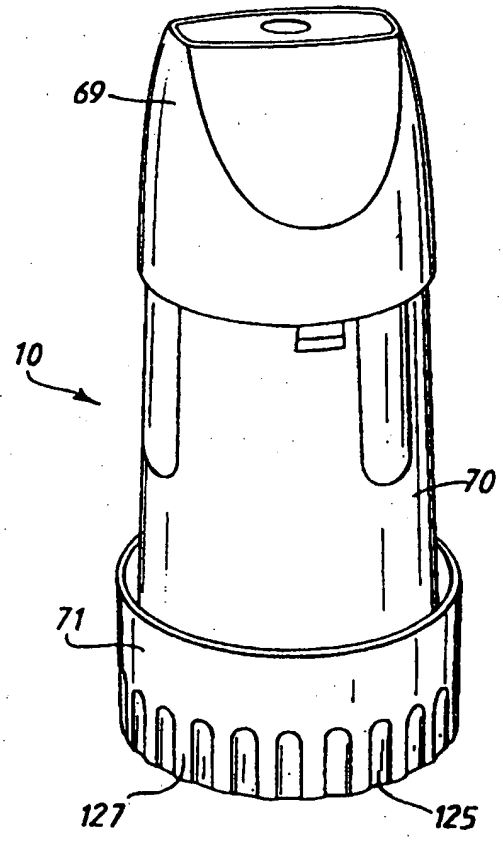


Fig.19

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(71) Applicant *(for all designated States except US)*: ASTRA AKTIEBOLAG (publ) [SE/SE]; S-151 85 Södertälje (SE).

(72) Inventors; and
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(74) Agent: ASTRA AKTIEBOLAG; Patent Dept., S-151 85 Södertälje (SE).

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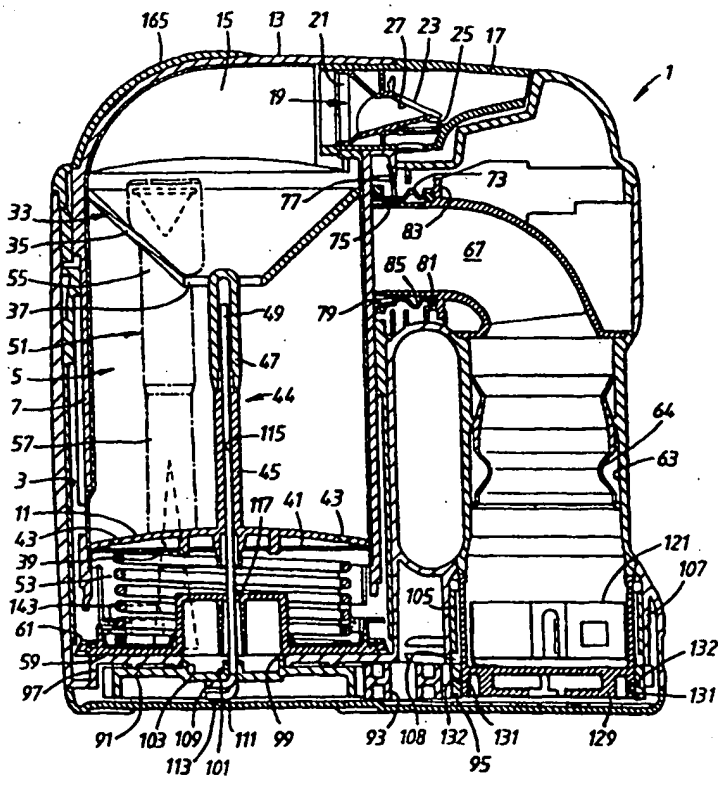
(57) Abstract

Device for providing a substance in a dispersion chamber (5) for inhalation, includes a slip clutch (121) for driving an inhaler (10), apertures (43) in the dispersion chamber to remove settled substance, a seal (75) between a channel (67) and the dispersion chamber, an enclosed passageway extending into the dispersion chamber from which rotational drive may be taken, a portion through which an indication on a housed inhaler may be viewed, a release mechanism (143) for the piston (59) of a suction chamber (53) and a component for simultaneously operating the grip portion (71) of a housed inhaler and opening an air path in the device.



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# INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/SE 98/00456

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61M15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61M F16J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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Int. -tional application No.
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This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

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3. ☐ Claims Nos.:
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## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-13, 79-80

   Inhalation devices with dosing mechanism and drive mechanism with slipping clutch and methods of operation.

2. Claims: 14-23

   Inhalation device with dispersion chamber with apertures and method of preventing accumulation of substance

3. Claims: 24-31

   Inhalation device with sealing for a moving component and method

4. Claims: 32-42

   Inhalation device with rotationally movable dispersion chamber and method

5. Claims: 43-59

   Inhalation device with indicator viewing and methods

6. Claims: 58-68

   Inhalation device with suction chamber and intermediate engaging component and method

7. Claims: 69-78

   Inhalation device with manoeuvring means operating dosing and opening air path and method

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